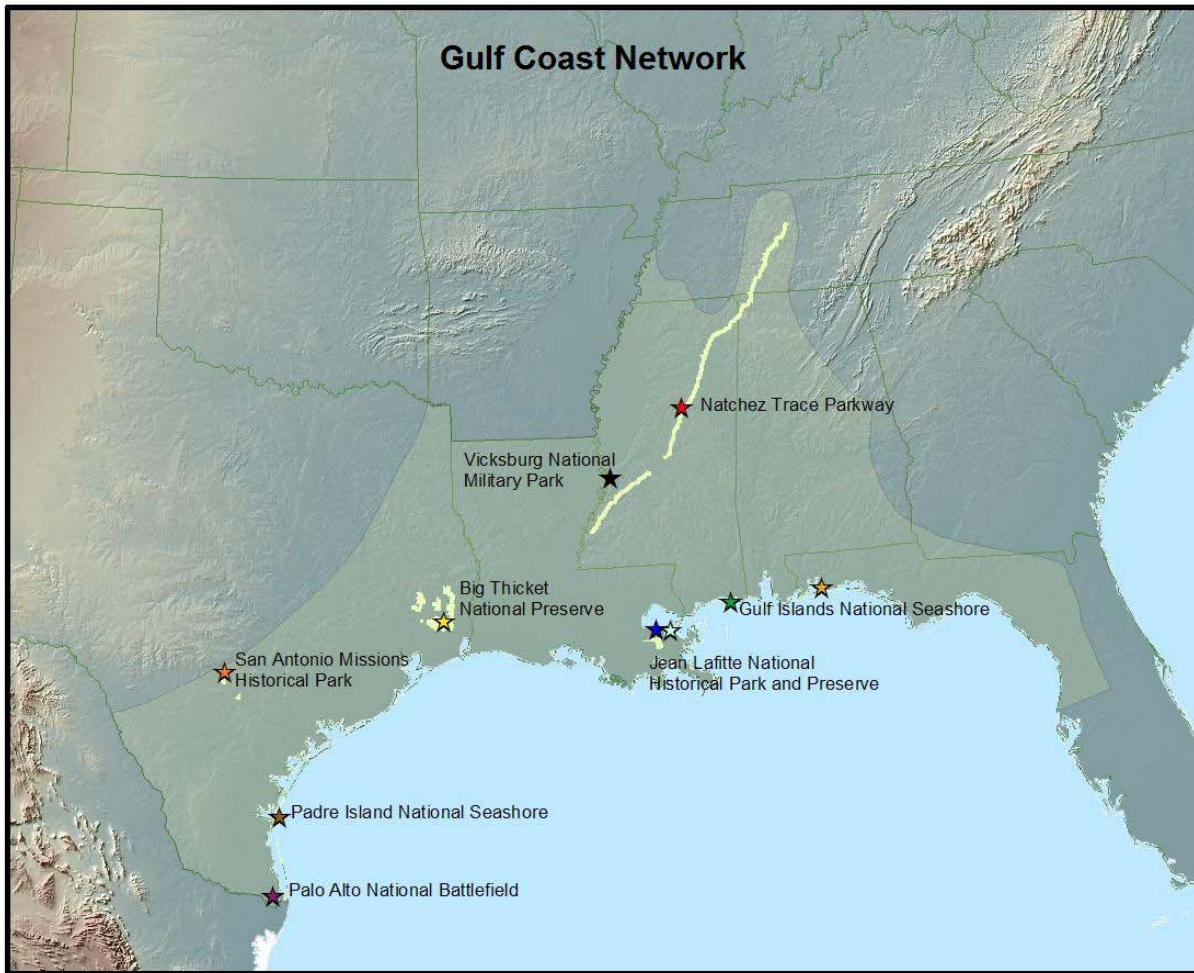


Natural Resource Summary for
Padre Island National Seashore
FINAL REPORT

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EXECUTIVE SUMMARY

Padre Island National Seashore (PAIS) was established in 1962 and consists of approximately 130,000 acres of land and water. At 70 miles, it is the longest stretch of undeveloped barrier island in the world and ranges in width from ½ to 3 miles. It contains tens-of-thousands of pristine wetlands and 29 rookery islands. PAIS is bordered by the Gulf of Mexico to the east and Laguna Madre to the west. Laguna Madre is one of only a few hypersaline bodies of water in the world and is also one of the most productive estuarine systems. Due to the pressure from growing development along coastal Texas, the habitat in the park has become an increasingly important resource for many resident and migrating species.

A number of vegetation surveys or studies have been conducted on PAIS, the island itself (both north and south Padre Island) and Mustang Island, beginning as far back as 1891. One detailed summary was produced of both the historical and current vegetation of Padre Island (including PAIS) and the surrounding areas. A number of historical descriptions of the island's vegetation during the 1600's through the late 1800's were included. In addition to summarizing the data from past resources, the report analyzed the context of these historic sources. A recent species list of the vascular plants on PAIS was developed using data from floristic studies as well as from the literature and documented 259 genera and 456 species from 77 families of flowering plants. Twenty-one species had not previously been documented on PAIS and 41 species had larger ranges than previously recorded. The communities described for PAIS were less diverse than other vegetation communities on the island and were apparently still recovering from overgrazing. In a second study, data from previous surveys were used to compare the vegetation of the northern Padre Island (including PAIS) to that of Mustang Island, Matagorda Island and southern Padre Island. Species richness and the number of species limited to the island were greatest on northern Padre Island, with its flora most similar to that of Matagorda Island.

Because a large portion of the park is water, a great deal of research has been directed toward the aquatic vegetation of PAIS and the surrounding waters, in particular the seagrass beds. Of the predominate seagrass species in these waters, shoalgrass, turtle grass, and manateegrass, have been the focus of most studies. Using past vegetation maps of the lower Laguna Madre, a decrease in acreage of shoalgrass and an increase in other seagrass species and bare bottom has been documented. Various studies have found that the conversion to other species was correlated with a change in salinity, dredging, and nutrient availability. The upper Laguna Madre and Baffin Bay hold almost 30% of the seagrass within Texas. In a 1997 summary report on the seagrass trends of the Corpus Christi Bay National Estuary Program, no turtle grass was found within the upper Laguna Madre, instead it is predominately shoalgrass. Research had found that the persistent brown tide was having a serious negative effect on the seagrasses within the lagoon. From 1988 to 1996 3.8% of the total seagrass acreage was lost.

Information on the mammals of the park was mainly collected during the 1970's and 1980's, with an emphasis on rodent species. Only two studies have examined the larger mammals on the park, both of which focused on coyotes. A number of checklists have been created over the years for PAIS and according to the NPSpecies database, a total of 60 species have been documented or were possible in the park. Several studies have been conducted on small mammal populations on Padre Island and the surrounding areas. Much of this work has focused

on the ecology of Padre Island or Gulf Coast kangaroo rat and the morphological differences that differentiate the species and its subspecies. In a study that compared the diversity of mammals that exist on the barrier islands of Texas and the adjacent mainland, correlations were found between species richness and island area and length. Additionally researchers concluded that the low species counts of the islands had more to do with the mammals' inability to survive the harsh island environment than a lack of colonization events.

During 2002 and 2003 the Texas Nature Conservancy conducted an inventory of herpetofauna on PAIS and documented 23 reptile and five amphibian species. This comprehensive study has been the only inventory conducted on PAIS and incorporated current data, through surveys and collections, as well as confirmed historical sightings and collections. A number of amphibian species found within the county were not detected on the park, likely due to the lack of available freshwater. Other than this survey, most of the herpetofaunal studies that have been conducted on the park have involved one of the five threatened or endangered sea turtles which inhabit the park. Most of this work has focus on the Kemp's ridley sea turtle. A plan to restore Kemp's ridley sea turtle nesting grounds on PAIS through a reintroduction program began in 1978 and continued through 1988. This 'Head-start' program involved the collection of eggs from Rancho Nuevo Beach, Tamaulipas, Mexico and their transportation to PAIS where they would be incubated, hatched and imprinted. Once imprinted, the young were moved to the National Marine Fisheries Center where they were raised for a year before they were released into the sea. After the 10th year of the Head-start program, the focus switched from reintroduction to the relocation and monitoring of turtles that returned to nest on the shores of PAIS, and the protection of those nests. During this time, a number of studies have been conducted to investigate topics such as the effect of temperatures on incubation and nesting of turtles, and the acclimation of the Head-start turtles to the natural environment. The number of nests on PAIS has been steadily increasing since 1996 and the park generates annual sea turtle reports documenting the success of patrol efforts, incubation, nesting, and strandings that occur within the park.

Birds have been very well studied on the park and the surrounding areas, more so than any other taxa. Studies have focused on a variety of topics including but not limited to abundance, food sources and availability, species diversity, reproduction, effect of anthropogenic and natural disturbances, and habitat use. The most comprehensive surveys of the general avian populations on PAIS were four year-long studies, which were conducted during the 1990's. Data were collected on species diversity, abundance, habitat use and bird activity (e.g., feeding, nesting), but focused on Threatened, Endangered, or Candidate species and those species that actively use the mudflats or beaches. The number of species detected on the western side of the island was nearly double that of the gulf side but all sections provided habitat for Threatened or Endangered Species for both feeding and/or nesting. This study found that certain birds preferred one side of the island and others switched between the two sides. A number of reports examined the diets and distribution of a variety of waterfowl species in the area, particularly the distribution of wintering Redheads and their effect on seagrass stands. These studies found that while freshwater and saltwater habitats were important for Redheads, they favored lower salinity areas where they consumed large quantities of the shoalgrass rhizome biomass. Peregrine Falcons have also been a major focus of a large quantity of avian research since PAIS is a major staging area for their migration. An extensive effort to monitor Peregrine Falcons on PAIS was initiated

during 1977. Fall and spring migrants were observed, trapped, banded and bled to test for pesticides and genetic markers. Information was summarized on a seasonal or yearly basis with a 10-year summary of the project written in 1988. Additional studies were conducted on the wintering behavior of Peregrine Falcons through the use of radio telemetry on birds that were caught during migration on South Padre Island and Laguna Madre. Due to the effect the monitoring was having on other species, the project was discontinued on PAIS after the fall of 1993, but monitoring still occurred outside of the park after this period.

Although there have been no large scale fish surveys conducted on PAIS, almost 150 species of fish have been documented at the park. Texas Parks and Wildlife have monitored finfish in the area for an extended period. A literature compilation relating to finfish in the area and an annotated species list will be completed. Additionally because of the high concentration of commercial and sport fishermen in the area, fish species in the open waters have been well documented. Those species located inland have not been well studied. Two studies were conducted in the late 1980's to examine the baseline fish and plankton populations for PAIS. The first study examined the species and abundance of surf fish in the Gulf and collected information on migration patterns, size, growth, seasonal variations and relationship between inshore plankton and fish. Sixty-two fish species were documented and no long-term effect of red tides was seen on fish populations. A second study also collected data on the fish and plankton populations but sampling occurred in the Laguna Madre.

No comprehensive studies of the invertebrate populations of PAIS have been conducted. Instead, information has been gathered by site specific or population specific studies and has covered a wide variety of species and habitats. Limited work has been conducted on terrestrial species, instead most has focused on the aquatic invertebrates such as mollusks and crustaceans and documented such things as the species diversity, density, daily and breeding activities, habitats, seasonality, and the effects of parasites, anthropogenic disturbances, salinity and temperature on the populations.

A number of documents describe the general geology of the island and the area, including some specific to the park. Studies have also focused on the transportation of sediment through wind and water and the resulting effects on this barrier island. The underlain formation of Padre Island is an ancient barrier bar deposited during the late Pleistocene period. The sediments deposited on this barrier were of the Quaternary Period and were formed during the Recent Epoch and primarily consist of sand and shell. The sediment along Padre Island varies down its length due to multiple sources and the way in which deposition occurred. Sand along the southern end is coarse and was deposited by the Rio Grande. The finer sand in the north was deposited by the Nueces, Colorado and several other rivers to the north. A transition zone exists in the middle of the island where the sand is an equal measure of the two sizes. Grain size does not vary much due to season in the southern and northern provinces, but it does in the convergence area. The Natural Resource Conservation Service is conducting a soil survey specific to the park and is expected to be complete in 2004. A number of studies have also been conducted on the erosion and deposition in the area. Shoreline profiles and profile data from these studies were used to establish protocol for monitoring accretion and erosion at PAIS. A sediment budget analysis for Laguna Madre found that the lagoon was not filling up as some have said, but instead was migrating westward.

All of the information on PAIS's water resources is currently being summarized by researchers from Texas A&M University-Corpus Christi and there are plans for the National Park Service's Water Resource Division to examine the park's watershed. The groundwater at PAIS has three distinct zones: the hypersaline, the freshwater and the seawater. Fresh shallow groundwater (3-15 feet in the north, 3-10 feet in the south) exists in the dunes as a lens floating on saline water but is probably not more than a few feet deep. The island's groundwater is not directly connected to the mainland aquifer; instead the freshwater recharge comes from precipitation on the island. Recent monitoring found high levels of ammonia in wells near the saline zone. It was thought that this was due to high nitrogen production from the algal mat on the wind tidal flats instead of an anthropogenic source. A number of studies have been conducted on the surface water of the park and the surrounding waterbodies. A baseline inventory of water quality of PAIS found 13 groups of parameters that exceeded water quality screening limits at least one time (between 1941 and 1998) in the study area. This report described waters that have been historically impacted by anthropogenic activities such as development, marine traffic, oil and gas exploration and development, recreation, wastewater discharge, atmospheric deposition and dredge and spoil operations. Portions of the water in the Gulf of Mexico and Laguna Madre near PAIS have been listed on the Texas State impaired list because they do not meet the standards set for their use due to potential contamination by human pathogens, low levels of dissolved oxygen, and elevated levels of mercury in fish. Water quality has also been monitored in ponds within PAIS. These surveys have documented an increase in phosphorus levels, color change, and a decrease in salinity.

There are a number of active monitoring stations on the park and in surrounding areas that provide information on the park's air quality. Two long-term collection programs have recently placed monitoring stations on the park and are currently collecting data on the local air quality. Data from these locations are contributing to larger studies that examine the formation and transport of air pollutants along the Gulf Coast of Texas and background atmospheric levels of dioxin-type compounds, especially those near agriculture. An air emissions inventory conducted at the park during 2001 documented the sources and magnitude of in-park emissions, identified strategies to mitigate emissions, and evaluates compliance with state and federal air pollution regulations. Statewide collection sites for the National Atmospheric Deposition Program/National Trends Network data show a slight decrease in wet sulfate and wet nitrate concentration, but no trend in wet ammonium concentration and deposition or in wet sulfate and wet nitrate deposition.

There are a number of aquatic and terrestrial ecosystems that exist on PAIS including the dunes and beaches, ponds and wetlands, spoil islands, and estuaries. Studies have been conducted on the dune habitat of PAIS and have focused on the dune types, vegetation, cycles, and factors that control them. A good deal of research has also examined the effects of natural processes and human induced changes on the dunes. Historical disturbance to the island, such as overgrazing and drought, have been compounded by high winds and tides of hurricanes, and exacerbated by the large volume of visitors the park receives. Although a barrier island provides protection for mainland coastal zones, if foredunes erode due to human or natural influences, protection for the coast declines. Native grasses have been found to be the best vegetation to help stabilize these foredunes. A few studies have examined the inland ponds on PAIS. These studies examined the flora and fauna, as well as water quality parameters. Most studies that have been conducted on

the spoil islands have focused on the avian species that inhabit the islands. Some studies have found that the presence of people and the addition of spoil to the islands during the incubation and early nestling stages negatively affected avian nesting success. The Laguna Madre, one of the largest ecosystems in the park, has been the focus of many studies that examined such things as the physical properties of the water (e.g., salinity, movements, water circulation, and temperature) and the organisms that inhabit the lagoon (including plankton, crustacean, mollusks, birds and fish). In 1990, a phytoplankton bloom known as the brown tide formed in the Laguna Madre. A number of studies have examined why the bloom began (e.g., combination of low grazer populations, extreme hypersalinity of water due to drought, and a large nutrient flush due to a fish kill) and possible reasons for the resilience of the brown tide (e.g., growth rate is greater than its grazers, low turnover rate, hypersalinity of the water, and its thick protective mucus layer). Seagrass beds have also been the focus of a great deal of research. These studies have examined such topics as the availability of nitrogen in the system, the effect of bacterioplankton on the cycling of carbon and its effect on seagrass productivity, as well as the change in seagrass composition. Much of the work that has occurred on the tidal flats, which divide the lagoon into what is known as upper and lower Laguna Madre, has examined the macroinvertebrate and avian populations, and links between the two. Shorebirds have been shown to have a significant effect on macrobenthos abundance in these flats but presence or absence of the shorebird species was not useful in predicting critical habitats.

Many of the park's management issues concern the protection of natural resources and mitigating the effects of various types of disturbance such as human use, cattle grazing, fire and storm impacts. Human use has caused both direct (e.g., destruction of habitat from pedestrians and vehicles, dredging and development) and indirect (e.g., contamination from trash, oil spills, and pesticide use) management concerns for the park. Multiple studies have examined the effects of vehicles and pedestrians on the beach, dunes and the existing biota of PAIS. Not surprisingly, most found that areas with heavy traffic displayed a decline in density and species richness, and cause areas to be less stable during storm events. Hurricanes are one of the biggest concerns for the park as they can have a devastating effect on the biological communities, park structures and facilities, and cause morphological shoreline changes. Beach erosion is also a prevalent management issue at PAIS and many efforts have been made to study and manage this problem. Grazing had occurred continuously on the island for 150 years until 1971, when cattle were removed. Overgrazing and drought previously denuded a once largely vegetated island and increased the accumulation of sand in Laguna Madre. Since grazing has been phased out on the island, vegetation has rebounded and consequently reduced sand flow and caused a shoreline retreat at Laguna Madre. Due to the number of oil tankers in Corpus Christi Bay and seeps from the floor of the Gulf of Mexico, threats of oil spills remain a concern for the park. Studies of areas affected by spills have found decreased abundance and absence of certain species, but these effects were not thought to be long lived. Other forms of contaminations such as trash and pesticides have also been monitored on the park to determine the amount, type, and possible effects on the park and its inhabitants. There has been a decline in the level of organochloride pesticides such as DDE detecting in park fauna since the 1970's but chemicals such as polychlorinated biphenyls (PCBs) are now being detected.

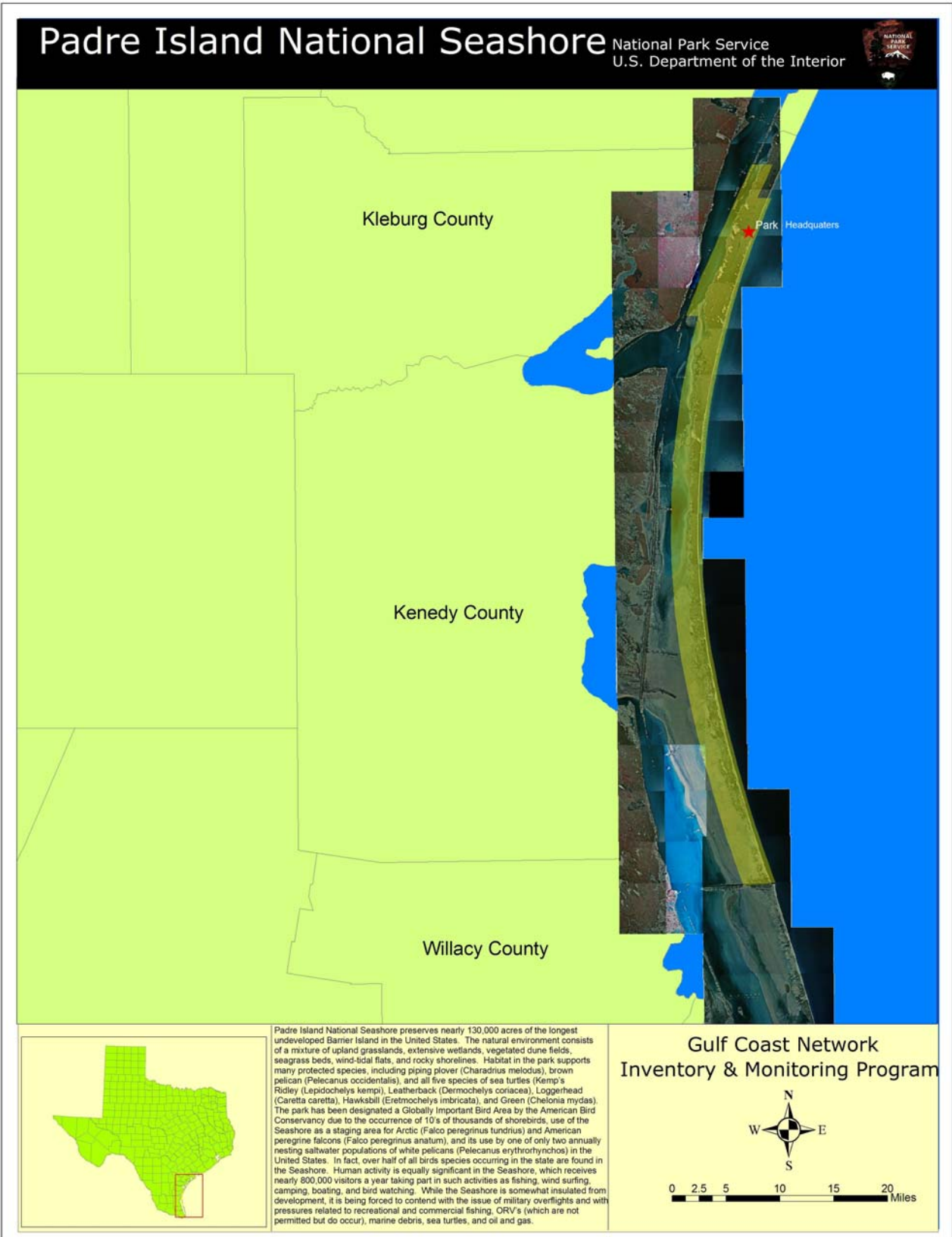


Figure 1. Location and extent of the PAIS, one of eight parks in the Gulf Coast Network

RESEARCH REVIEWS

BIOLOGICAL RESOURCES

Padre Island National Seashore (PAIS) was established in 1962 and consists of approximately 130,000 acres of land and water. At 70 miles, it is the longest stretch of undeveloped barrier island in the world and ranges in width from ½ to 3 miles. It contains tens-of-thousands of pristine wetlands and 29 rookery islands. PAIS is bordered by the Gulf of Mexico to the east and Laguna Madre to the west. Laguna Madre is one of only a few hypersaline bodies of water in the world and is also one of the most productive estuarine systems. Due to the pressure from growing development along coastal Texas, the habitat in the park has become an increasingly important resource for many resident and migrating species.

A couple of reports have provided a general overview of the park and surrounding habitats. The Gulf Coast Association of Geological Societies produced a field guide from a convention field trip in 1972 that gave an overview of the geology, history and biota of the park (Gulf Island Association of Geological Societies 1981). The guide listed common species for mammals, birds, fish, snakes, crustaceans and mollusks. Tunnell and Judd (2002) provided a good overview of the research that has been conducted in the Laguna Madre as well as important conservation issues and recommendations. They described the geology, hydrology and ecology of the system. They discussed multiple ecosystems in the estuary including seagrass meadows, open bay, wind-tidal flats and barrier islands, and the organisms that inhabit them.

VEGETATION

Terrestrial

Surveys, descriptions, checklists

General area, Padre Island and Mustang Island

A number of vegetation surveys or studies have been conducted on Padre Island or Mustang Island. Two of the earliest of such studies were Lloyd (1891) and Cross and Parks (1937). Lloyd described the vegetation and physical characteristics of Padre Island and Cross conducted a vegetation study that included PAIS. Jones et al. (1961) compiled a list of the flowering plants and ferns of the Texas Coastal Bend, which included PAIS. In a separate document, Jones (1966) completed a checklist for the plants of Padre and Mustang Islands. Gillespie (1976) completed an annotated checklist of the flowering plants of Mustang Island. Jones (1977) surveyed the flora of Padre and Mustang Islands as well as the adjacent waters.

Multiple studies also have been conducted or checklists created on the flora of South Padre Island. Lonard et al. (n.d.) conducted a study to examine the species composition of vegetation found in the non-tidal wetland communities on South Padre Island. Lonard and Sorensen (1974) created a checklist for the angiosperms on South Padre Island. Judd et al. (1977) reported on a study of the vegetative patterns found in the six topographic zones on South Padre Island. They identified 204 plant species during this study. Two hundred and seven flowering plants were documented by Lonard et al. (1978). Bletsch (1980) examined flowering plants on South Padre

Island for kranz leaf anatomy. Lonard and Judd (1980) studied the phytogeographic affinity of 99 species native to South Padre Island. They found that two species were endemic to the island, but 44% could also be found on the mainland. Twenty-eight percent had tropical affinities and likely reached the island by oceanic drift. They found that birds were the most important dispersal mechanism for the island's native species. Lonard and Judd (1981) described the terrestrial vegetation of South Padre Island and Lonard and Judd (1989) examined the flowering and fruiting of 74 species of native angiosperms found on South Padre. Everitt et al. (1999) examined reflectance characteristics of vegetation and associated soil conditions on South Padre Island. Many species could be identified with the color-infrared aerial photographs but other visual cues such as growth form, shape and texture were helpful in discriminating species.

Padre Island National Seashore

A number of surveys listed in the previous section sampled habitats within PAIS. There have also been a number of surveys and checklists that focused specifically on PAIS.

McFarland (1973) examined the soil properties, such as salt, organic matter and essential element levels, of multiple sites on Padre Island and the effects on species diversity of plants growing on the sites.

Rabalais (1975c) created a PAIS vegetation checklist. This list was based on the work done by Jones et al. (1961), Jones (1966) and Rechenthin and Passey (1967). In a 1975 document sent to the park, Jones listed sensitive plant species existing at PAIS and recommended that their collection be limited in order to preserve their populations (Jones 1975).

Chaney et al. (1980) conducted transects on four beach areas on PAIS to examine the vegetation and sedimentation of the foredunes. Species composition and height of foredunes varied but no trends were found.

Drawe et al. (1981) studied the soil and vegetation of five habitats on PAIS. They found the soil on the island was deficient in Nitrogen (N) and Potassium (K), and plant growth was limited by the salinity found in salty sands and the shoregrass flats. The predominant habitat, the low coastal sands, had the greatest diversity of plant species.

Brown et al. (1989) produced a detailed summary report of both historical and current vegetation of Padre Island (including PAIS) and the surrounding areas. A number of historical descriptions of the island's vegetation during the 1600's through the late 1800's were included. In addition to summarizing the data from past resources, they also attempted to analyze the context of these historic sources.

In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the plants observed surrounding these ponds.

Drawe (1992) conducted vegetation surveys along four transects that were spaced throughout the park. He documented 140 species during the spring surveys, with the greatest diversity found in

the northern end of PAIS. Species composition of the major plant communities was also detailed. Surveys were to be repeated that fall.

A. Nelson (1997) and Nelson et al. (1997, 2000b) provided a detailed summary of the vegetation studies and surveys that have occurred at PAIS. Nelson et al. (1997) conducted a preliminary survey of the habitats near Big Ball Hill in PAIS. Using previous surveys and their own, they detailed species encountered in each habitat and compared the communities of north and south Padre Island. This survey documented 69 genera and 83 species of flowering plants in the Big Ball Hill region. Negrete et al. (1999), Negrete (2000) and Nelson et al. (2000c) used the data from their floristic studies as well as from the literature and created an annotated list of the vascular plants on PAIS. The list documented 259 genera and 456 species from 77 families of flowering plants at PAIS. Twenty-one species had not been documented on PAIS and 41 species had larger ranges than previously recorded. Based on community structure they divided the area into five zones. These communities were less diverse than other vegetation communities on the island and were apparently still recovering from overgrazing. Nelson et al. (2000a) used data from previous surveys to compare the vegetation of the northern Padre Island (including PAIS) to that of Mustang Island, Matagorda Island and southern Padre Island. Species richness and the number of species limited to the island were greatest on northern Padre Island, with its flora most similar to that of Matagorda Island. This group of papers represents the most comprehensive vegetative studies and species lists for the park (D. L. Echols, personal communication, 12 March 2004).

Laine and Ramsey (1998) completed the landcover classifications for PAIS. These landcover maps could be used to find appropriate locations for study plots, location of sensitive habitats and provide needed information about park resources during fires (Ramsey et al. 2002).

Spoil Islands

A couple of studies have described or examined the vegetation of the spoil islands that were created during the dredging of the Gulf Intracoastal Waterway (GIWW) through Laguna Madre. During a survey for birds on Bird Island, Cahn described the sparse, low-lying vegetation found on the island (Cahn 1922). Mendoza and Ortiz (1974) examined the vegetation, bird populations and soils of 11 spoil bank islands in the upper Laguna Madre. They conducted soil analysis and created checklists for the plants and birds found on the sampling sites. Chaney et al. (1978) conducted a study on spoil islands in Laguna Madre to examine soils, vegetation and animal populations, use by seabirds and wading birds, and compared avian nesting sites between 'natural' sites on the coast. In a follow-up to this study, Sims et al. (2002) documented the current vegetation and physical characteristics of the islands and compared them to historic conditions. Twenty-two plant species were documented. Recommendations were given for the management for these islands. Smith and Sims (2002) conducted a study of eight spoil islands to examine annual changes in vegetation. They documented 54 species from 20 families but did not find changes in the overall structure of the vegetation during the year.

Individual species studies

Baker (1972) examined the effects of N, Phosphorus (P) and K fertilizers on sea oats (*Uniola paniculata*) and bitter panicum (*Panicum angustifolium*) both at PAIS and in greenhouses. He found that both species responded with increased vigor to the addition of fertilizer. Seneca (1972) examined the variations that occur between different populations of *U. paniculata*.

Devall and Thien (1989) examined the reproductive biology of the beach morning glory, *Ipomoea pes-caprae*, along the Gulf of Mexico. Lonard and Judd (1999) discussed the spatial distribution of the beach morning glory, *I. imperati*, on and along coastal beaches. Populations on South Padre Island were limited by hurricanes.

Aquatic

Surveys, descriptions, checklists

Merkord (1978) examined the distribution and abundance of the five predominant seagrass species in Laguna Madre, which is one of only two hypersaline lagoons in North America. Using past vegetation maps of the lower Laguna Madre, Quammen and Onuf (1993) documented a decrease in acreage of shoalgrass (*Halodule beaudettei* formally *H. wrightii*) and an increase in other seagrass species and bare bottom. Conversion to other species was correlated with a change in salinity and dredging was the suspected cause of the loss of seagrass. Onuf (1996a) described the spatial and biomass variation that occurred in the four seagrass species across Laguna Madre.

Humm and Hildebrand (1962) found 193 varieties of marine algae from samples taken at various points along the shore of the Gulf of Mexico including some in the vicinity of PAIS. Dykstra (1966) examined the algae around Padre and Mustang Islands. In a waterfowl carrying capacity study in the upper Laguna Madre area, West (1969) developed vegetation maps, created permanent vegetation transects and conducted an inventory of aquatic flora and fauna that were important for waterfowl subsistence. Lonard and Sorensen (1974) created a checklist for the macroscopic marine algae on South Padre Island. Edwards (1976) conducted a study of the seaweeds and seagrasses off the coast of Port Aransas. They documented 88 species of benthic marine algal vegetation. Baca et al. (Baca et al. 1977, 1979) documented the ecology of several species of benthic marine algae on South Padre Island. They created a list of the benthic marine algal vegetation found on South Padre, which included 37 species not detected on previous studies. Sorensen (1979) created a guide to the seaweeds found on South Padre Island. Dunton (1994b) examined the abundance and biomass of the marine algae found at the north jetty at Port Mansfield, Texas. Kaldy (1996) found *Halimeda incrassate*, a rhizophytic alga, in the lower Laguna Madre, documenting a major range extension as prior to this it had not been reported in Texas. Strenth (2001) described common caulerpa (*Caulerpa prolifera*) populations in Laguna Madre. DeYoe and Hockaday (2001) examined the range expansion of two seaweeds (*Codium taylorii* and *Caulerpa prolifera*) into Laguna Madre.

In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the plankton, among other taxa, found within these ponds.

Seagrass studies

Salinity tolerance of shoalgrass and manateegrass (*Syringodium filiformis*) was examined to determine waterfowl sustainability in PAIS (McMahan 1968). McMahan found shoalgrass could exist in a wider range of salinity levels (9.0 to 52.5 parts per thousand [ppt]) than manateegrass, which did best at 35.0 ppt but died at 52.5 ppt. Shoalgrass was found to be an important food source for waterfowl, shrimp and fish, but manateegrass was not. He also discussed possible effects of construction of fish passes and river diversion projects that may affect water salinity and increase salt intolerant species such as manateegrass.

Pulich et al. (1997) discussed seagrass trends and current status in the Corpus Christi Bay National Estuary Program (CCBNEP) and correlated possible causes for these distribution trends. They found that the upper Laguna Madre and Baffin Bay hold 28.5% of the seagrass within TX. They found no turtle grass within the upper Laguna Madre, instead it is predominately shoalgrass. Although the northern portions of the study area remain relatively stable, research had found that the persistent brown tide was having a serious negative effect on the seagrasses within the lagoon. From 1988 to 1996 3.8% of the total seagrass acreage was lost.

Negrete (2000) examined a tidal flat community along Laguna Madre bordering PAIS and found it was dominated by *Monanthochloe littoralis* and other salt tolerant plants. Eldridge and Morse (2000) modeled the seagrass-sediment relationship in the Laguna Madre. They found an interaction between seagrasses and sedimentary diagenetic processes that lowered the sulfide concentration in the sediment to non-toxic levels for the seagrasses. Kaldy et al. (2002) examined the contribution of seagrass to the net primary production in the lower Laguna Madre. Seagrass may be more important for structural habitat than Carbon (C) in the water column.

Turtle grass studies

Kaldy (1997) examined the growth and ecology of turtle grass (*Thalassia testudinum*) in Laguna Madre. Changes in energy allocation in different seasons and ages were studied as well as techniques for aging plant shoots.

Lee (1998) conducted a study to examine the N budget for turtle grass between two distinct populations in Corpus Christi and Laguna Madre. High sediment N caused increased leaf growth and plants in low level conditions increased belowground growth. Experiments suggest that the Laguna Madre population was limited by availability of sediment N. Herzka and Dunton (1998) conducted a study of turtle grass in the lower Laguna Madre to examine the influence of light and C in current production models. Lee and Dunton (1999a&b) investigated how changes in N availability in sediments affected the C and N content of turtle grass in Laguna Madre. Increased N levels produced high leaf growth and low levels encouraged high belowground growth.

Kaldy and Dunton (1999) examined possible explanations for the rapid northern expansion of turtle grass in Laguna Madre. Ecological features such as high seed production, high survival rate and floating seed as well as changes in C cycling were important in the dispersal and colonization of the species.

Kaldy et al. (1999) examined turtle grass shoots in Laguna Madre to assess the accuracy of determining shoot age. They found the growth was influenced by site, season and yearly variation, and affected the accuracy of the method. Kaldy and Dunton (2000) investigated whole plant growth and reproduction in turtle grass and found that seasonal variation of environmental factors, such as day-length, temperature and irradiance, were the most important factors in determining growth. Lee and Dunton (2000b) studied turtle grass in Corpus Christi Bay and lower Laguna Madre to examine how sediment ammonium affected seagrass growth and allocation. Seagrass productivity in Laguna Madre was limited by N availability.

Lee and Dunton (2000a) investigated the interaction between turtle grass and sulfide in Corpus Christi Bay and Laguna Madre. Seagrasses modified the chemical environment of the sediments and created a beneficial environment for seagrass production.

Major and Dunton (2002) tested the extent to which turtle grass can compensate for light variation. Turtle grass could adjust both in structure and function to adapt to changes in light availability.

Shoalgrass

Circe (1979) examined shoalgrass in four zones - pioneer, complete, transition and original - around spoil islands. He found that the zones differed in water depth, vegetative biomass, microinfauna, sediment grain size and C content.

Opsahl and Benner (1993) studied the decomposition of senescent blades of shoalgrass in the water column of Laguna Madre and documented a large initial organic matter loss due to leaching and found photobleaching was important in degrading plant tissues.

Custer and Mitchell (1993) examined the shoalgrass beds and biota in the lower Laguna Madre for the presence of trace elements and organochlorine compounds, which existed in elevated levels near agricultural sources. Levels varied for the trace elements and chemicals. Mercury was highest near agricultural areas in both sediment and blue crab (*Callinectes sapidus*) populations, as was DDE. Arsenic levels were lowest in blue crabs, shoalgrass and brown shrimp (*Penaeus aztecus*) near agriculture.

Dunton (1994a) studied the effect of light availability on seasonal growth and biomass of shoalgrass along the south Texas Coast. Populations in Laguna Madre experienced decreases in growth and biomass due to low light conditions caused by the brown tide. Dunton and Tomasko (1994) examined the photosynthesis versus irradiance of shoalgrass from Laguna Madre. Onuf (1996b) examined the effect of the light reduction caused by the brown tide on shoalgrass distribution. No response was detected in the first two years but losses were seen by the winter of 1993. Burd and Dunton (2001) examined the importance of light in the above and below ground growth of shoalgrass and successfully modeled the changes in biomass using data from Laguna Madre.

Tomasko and Dunton (1995) examined four techniques to estimate daily C budgets for shoalgrass in Laguna Madre and found that they varied in accuracy and recommended using whole plant estimates for obtaining realistic estimates.

Dunton (1996) studied the seasonal changes in photosynthetic production and whole plant biomass of shoalgrass along the Gulf of Mexico with respect to an estuarine gradient. Shoalgrass grew equally well in a range of salinities, nutrient levels and light availability. Kowalski (1999) examined the production of shoalgrass in lower Laguna Madre. The species showed a lower growth rate and biomass than other Texas estuaries and was likely nutrient limited, which may explain the current displacement by turtle grass.

Hicks et al. (1998) monitored changes resulting from abnormally cold temperatures on shoalgrass. Freezing did not affect the above or belowground biomass.

Major and Dunton (2000) examined photosynthesis in manatee grass and found it may have the ability to modify its photosynthetic apparatus structure in response to light availability.

Fungi

Little is known about the fungal communities at PAIS. Three small surveys have been conducted but none were comprehensive. Koehn (1982) collected 34 species of fungi from beach foam samples collected over a 23-month period on North Padre Island. Oxley (1992) surveyed three brackish ponds on PAIS to determine which fungi inhabit the ponds. She collected samples, looked for fungal relationships in the ponds and examined whether 'true' marine species inhabited environments that were not entirely marine. In a related study, Sissom et al. (1990) collected and summarized data on fungi from three freshwater ponds on PAIS.

Experts: Terrestrial: Robert Lonard (retired), Lynn Drawe (Director- Welder Wildlife Foundation), Alan Nelson (Tarleton State University) Aquatic: Chris Onuf (USGS Corpus Christi), Ken Dunton (University of Texas Marine Science Institute)

MAMMALS

Information on the mammals of the park was mainly collected during the 1970's and 1980's, with an emphasis on rodent species. A number of checklists have been created over the years for PAIS and according to the NPSpecies database, a total of 60 species have been documented or were possible in the park. A collection of 19 species, mostly rodents, was collected from 1965-1981 on PAIS and Mustang Island and was housed in the museum collection, at the PAIS headquarters.

General surveys, checklist

Raun (1959) created a checklist of the mammals found on Mustang and Padre Islands. Using field guides and research in the park, Rabalais (1975a) created a list of 49 species of mammals

(including 10 marine species) that existed or could have existed within the park. Most of the land mammals were small, nocturnal and/or burrowing. Additionally, Baker and Rabalais (1978) created a list of the terrestrial vertebrates of PAIS.

Harris (1988) produced an annotated species list for the mammals of Padre Island using historical and field collection data. He conducted small mammal trapping (including bats) on PAIS and reviewed regional museums for specimens captured on the island. He then searched the literature for species not accounted for in the collections. His research documented thirty-three species on Mustang and Padre Island and provided a good review of previous collection efforts on the island.

Goetze et al. (1997) conducted mammalian density and diversity surveys in conjunction with their vegetation surveys of the Big Ball Hill Region. They provided a brief but detailed review of previous sampling efforts in the area.

In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community including mammals that utilized the pond during the project.

Large mammal survey, studies

Very few studies have been conducted on the larger mammals of PAIS. During the 1970's, a Pan American University graduate student examined the food habits of coyotes (*Canis latrans*) on Padre Island and Laguna Atascosa Wildlife Refuge (Escue n.d.). Twenty years later, Snodgrass (1997) examined the diversity and seasonal variance of prey food in coyote scat on two barrier islands, including Padre Island, and two mainland sites. Mammals were the dominant food sources on all sites, although barrier island diets were more variable. Several animal species were documented in the scat from Padre Island.

Small mammals survey, studies

Several studies have been conducted on small mammal populations on Padre Island and the surrounding areas. Much of this work has focused on the Padre Island or Gulf Coast kangaroo rat (*Dipodomys compactus*).

True (1889) described two new species of rodents, *Geomys personatus* and *D. compactus*, first documented on Padre Island. Johnson and Selander (1971) conducted a study examining the genetic variation found in 11 species of kangaroo rats (*Dipodomys* sp) existing in the western United States, including samples of Ord's kangaroo rat (*D. ordii*), that were collected from PAIS. Kennedy et al. (1973) studied the activity patterns of *D. compactus* and found it had strong nocturnal behavior. McCoig (1983) also studied *D. compactus* populations but examined the habitat utilization within a beach community on PAIS. Baumgardner and Schmidly (1981) examined the morphological differences between *D. compactus* and *D. ordii* and found the two were taxonomically distinct. They also found evidence for the existence of two subspecies of *D. compactus*, *D. c. compactus* (barrier islands) and *D. c. sennetti* (mainland). Previously a different subspecies was described for Mustang Island, Padre Island, and the barrier islands of

Tamaulipas, Mexico. Smith (1986) compared the morphological variations of the Gulf Coast kangaroo rat on barrier islands, Mustang and Padre Islands, and mainland. She found morphological differences which could separate *D. compactus* and *D. ordii*.

Baker and Lay (1938) compared rodent populations between Mustang and Galveston Island. They found that non-indigenous rodents were well established on Galveston Island and the cotton rat (*Sigmodon* sp.) was the only native species found on the island. Levels of non-indigenous rodents were lower on Mustang Island due to the lack of freshwater and the relatively recent addition of Port Aransas as a seaport.

Yzaguirre (1974) examined the abundance and diversity of rodents in four habitats on one portion of PAIS. Of the habitats sampled, rodents were only captured in coastal dunes and low coastal sands; no rodents were captured or noted in salt marsh or shoregrass communities.

Baccus and Horton (1979) conducted a survey of small mammals in the beach-foredune habitat in a study examining the effects of vehicular traffic on the PAIS environment. They documented five species of small mammals whose preferred habitat varied according to the amount of vegetative cover. They found that as beach traffic increased, mammal diversity and abundance decreased.

Segers and Chapman (1984) conducted a study on the spotted ground squirrel (*Spermophilus spilosoma*), which inhabits the sand dunes and washover zones on PAIS.

Goetze (1999) conducted a study which examined the community relationships between small mammals on PAIS.

Hice and Schmidly (2002) used historical records and fieldwork to compare the diversity of mammals that exist on the barrier islands of Texas and the adjacent mainland. They found correlations between species richness and island area and length. They also concluded that the low species counts of the islands had more to do with the mammals' inability to survive the harsh island environment than a lack of colonization events.

Bats surveys, studies

Zehner (1985) documented the first sighting of the eastern pipistrel (*Pipistrellus s. subflavus*) on PAIS. Although it was a common cave bat in East and Central Texas, this was the first record of the species on the barrier islands of the Texas Coast.

Marine mammal survey, studies

Shane (1977) studied Atlantic bottlenose dolphin (*Tursiops truncatus*) populations in the Aransas Pass area. She examined home ranges, daily and seasonal movement, pod size and behavior.

Experts: Liz Smith (Texas A&M, Corpus Christi), Allan Chaney (retired dean of A&M Kingsville)

HERPETOFAUNA

Only one comprehensive study of terrestrial reptiles and amphibians has occurred on the park. This study incorporated current data, through surveys and collections, as well as confirmed historical sightings and collections. During 2002 and 2003 the Texas Nature Conservancy conducted an inventory of reptiles and amphibians on PAIS (Duran 2004). Multiple traps (minnow traps, hoop traps and two types of drift fence arrangements with pitfall traps), surveys (visual, auditory and road), as well as a limited number of coverboards were used to sample the amphibian and reptile populations. There was a collection of 67 reptile and amphibian species collected from PAIS and Flour Bluff from 1964-1979 reported in the NPSpecies database.

Reptiles

General surveys, checklists

Duran (2004) documented twenty-three reptile species, including six species of lizards, one alligator, one turtle and 15 species of snakes during the only inventory conducted on PAIS. In addition to those species that were documented through sampling, Duran also listed possible species that could occur in the area based on ranges and documented sightings and commented on the probability they exist within the park. One Federally Threatened S/A (Similarity of Appearance to a Threatened Taxon; American alligator, *Alligator mississippiensis*), one State Endangered (Texas scarlet snake, *Cemophora coccinea lineri*) and one Natural Heritage Vulnerable Status (keeled earless lizard, *Holbrookia propinqua*) species were detected during this study. A database and associated GIS shapefile were created to document observations that occurred on the park and North Padre Island.

Prior to this study, information on the terrestrial reptiles of the park was gained through sightings and data collected on peripheral studies. Laughlin (n.d.) created a checklist of the reptiles found in the Corpus Christi area including PAIS. Through the use of field guides and research in the park, Rabalais (1975b) created a list of 48 species of reptiles (including 5 sea turtles), which existed or could have existed in the park. Duran (2004) stated that some of these species do not exist within PAIS or on North Padre Island. In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community including reptiles. Snodgrass (1997) conducted a study on the food habits of coyote on the island. She listed two reptilian genera in the scat samples.

General studies

General sea turtle studies

Sea turtles, primarily Kemp's Atlantic ridley sea turtle (*Lepidochelys kempii*), have been well studied in PAIS. Using information from observations, documentation and anecdotal sources of sea turtles in the South Texas coastal area (including PAIS), Hildebrand (n.d.) described the biological factors (age, size, weight) and health (injuries, illnesses, survival) for each species. Rabalais (1980) conducted a three-year study to examine beach strandings of sea turtles along South Texas, particularly Mustang Island and North Padre Island. She found that more

loggerhead turtles (*Caretta caretta*) were found on the shores than Kemp's ridley, green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) turtles. Based on these stranding, Rabalais hypothesized that loggerheads were the most common turtle in the area.

Green sea turtle studies

Shaver (1994) examined the species diversity, seasonal abundance, residency, size classes and growth of turtles in Laguna Madre and Mansfield Channel. Green turtles were the most common species encountered. Catch-per-unit-effort was positively correlated with air temperature, water temperature and salinity. Shaver (2000) conducted a study on the distribution, abundance, migrations, movements, sizes, sex ratios and seasonality of green sea turtles along the Texas Coast through stranded ones, nettings, nests and tagged turtles. All netted turtles and 98 % of the stranding were juveniles. She found that the Mansfield Channel, which connects Laguna Madre to the Gulf of Mexico, was a developmental habitat for juvenile green turtles. A model for inshore records of green turtles is currently being created that will reflect potential areas of concentrated cold stunned sea turtles in the Laguna Madre (D. L. Echols, personal communication, 12 March 2004).

Kemp's ridley sea turtle studies

A plan to restore Kemp's ridley sea turtle nesting grounds on PAIS through a reintroduction program began in 1978 and continued through 1988 (National Park Service 1978). This 'Head-start' program involved the collection of eggs from Rancho Nuevo Beach, Tamaulipas, Mexico and their transportation to PAIS where they would be incubated, hatched and imprinted. Once imprinted, the young were moved to Galveston, Texas to the National Marine Fisheries Center where they were raised for a year before they were released into the sea. Shaver and Whistler (1979) documented Kemp's ridley sea turtles mating and laying eggs on PAIS. Recaptures of specimens that had been part of the Head-start program have been caught (Cultural Systems Branch and Pathology Research Group 1982).

A number of studies have been conducted to determine if Head-started turtles were adapting to the natural environment once they were reintroduced. Wibbels (1984) described the use of radio transmitters to locate yearling Kemp's ridley sea turtles from the restoration project. He discussed the swimming patterns and the success of relocating the turtles at sea. McVey and Wibbels (1984) described the growth of yearlings and their movements after being released into the Gulf of Mexico. Grassman et al. (1984) conducted various olfactory experiments on the artificially imprinted Kemp's ridley sea turtles. Using stranded Kemp's ridley sea turtles, Shaver (1991) examined the digestive tracts of wild and Head-started turtles to compare their feeding ecology. She found that both fed at water depths of less than 50 m and although there was variation between the two groups, Head-started turtles were adapting to feeding in the wild.

The incubation and nesting of Kemp's ridley sea turtles has also been a focus for multiple studies. Owens and Wibbels (1985) examined the effect of incubation temperature on the number of females that hatched from eggs incubated for the project. Chaney (1986) measured the temperatures of three beach sites on PAIS and the Playa de Rancho Nueve in Tamaulipas, Mexico to examine if temperature had any possible effects on sex ratios of incubating Kemp's

Atlantic ridley sea turtle eggs. After the 10th year of the Head-start program, the focus switched from reintroduction to the relocation and monitoring of turtles that returned to nest on the shores of PAIS, and the protection of those nests (Shaver 1990). McDaniel et al. (2000) investigated possible shrimping closure areas by overlaying sea turtle distribution and abundance with shrimping intensity. A closure was suggested off South Padre Island due to its potential for a nesting site for Kemp's ridley sea turtles. Wilkinson (2003) discussed the status of Kemp's ridley sea turtles on PAIS. The number of nests on the seashore has been steadily increasing since 1996. PAIS generates annual sea turtle reports documenting the success of patrol efforts, incubation, nesting, and strandings that occur within the park (D. L. Echols, personal communication, 16 September 2004).

Other Taxa

Species studies on reptiles inhabiting PAIS other than sea turtles is sparse. Ross and Judd (1982) examined and compared the lipid cycles of keeled earless lizards on Padre Island and the mainland. Trauth (1992) described a new subspecies of 6-lined racerunner (*Cnemidophorus sexlineatus*) on an inland sand dune plain and Padre Island.

Experts: Donna Shaver (USGS; sea turtles), Pat Birchfield (director of Gladys Porter Zoo), C. Michael Duran (The Nature Conservancy), Allan Chaney (Ecoservices; retired dean of A&M Kingsville), James Dixon (Texas A&M; wrote Reptiles of Texas but has not done herpetological work in park)

Amphibians

Amphibians have not been well studied in the park. A couple of reports have described the creation of reptile and amphibian checklists or collections, but there had been no complete surveys of the amphibians of PAIS prior to the recent Nature Conservancy study.

Through the use of field guides and research in the park, Rabalais (1975b) created a list of 8 species of amphibians that existed or could have existed in the park. In a later paper, Baker and Rabalais (1978) gave detailed information about each of the species they listed in their biological survey of the park. In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community including amphibians, which were only documented on one of the three ponds.

In Duran's draft report of his 2002-2003 study, he documented five species of amphibians, two of which had not been previously documented on the park (Duran 2004). A number of species found within the county were not detected on the park, likely due to the lack of available freshwater. No salamanders or newts were documented during the sampling. Duran also discussed which amphibian species, based on ranges and documented sightings, could occur in the area and commented on the probability they exist within the park. No Threatened or Endangered species were documented during this study.

Experts: C. Michael Duran (The Nature Conservancy), Allan Chaney (Ecoservices; retired dean of A&M Kingsville), James Dixon (Texas A&M; wrote Reptiles of Texas but has not done herpetological work in park), Gram Hickman (Texas A&M Corpus Christi, but has not worked in park)

BIRDS

Birds have been very well studied on the park and the surrounding areas. Studies have focused on a variety of topics including but not limited to abundance, species diversity, reproduction, effect of anthropogenic and natural disturbances, habitat use and food sources and availability.

All species

General surveys

A number of studies have documented the abundance and diversity of bird species in the park. Blacklock (1977) compiled a list of bird species found at Padre and Mustang Islands. He indicated seasonal presence, density, habitat identification, and arrival and departure dates for species on the list. In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community, including birds, using the ponds and surrounding habitat.

Blacklock et al. (1998) described habitat use and species diversity for migrant species using PAIS during spring migration. Gibbons (2000) reviewed the utilization of Padre Island by nearctic-neotropical migrant birds for migration and breeding periods. He found that Padre Island was important as stopover habitat for migrants but the diversity of breeding species was reduced due to predators and the lack of elevated nesting sites.

The most comprehensive surveys of the general avian populations on PAIS were four year-long studies, which were conducted during the 1990's (Chaney et al. 1993, 1995a& b; Ecoservices 1993). The first two studies focused on PAIS south of Yarborough Pass, with one conducted on the Gulf Beach and the second along Laguna Madre. The second two projects were conducted a few years later on the northern portion of PAIS from Yarborough Pass to the northern boundary; again with one project conducted on each shoreline. Data were collected on species diversity, abundance, habitat use and bird activity (e.g., feeding, nesting), but focused on Threatened, Endangered, or Candidate species and those species that actively use the mudflats or beaches. The number of species detected on the western side of the island was nearly double that of the gulf side during both sets of studies but all sections provided habitat for Threatened or Endangered Species for both feeding and/or nesting. They found that certain birds preferred one side of the island and others switched between the two sides.

Studies have also been conducted on the nearby spoil islands. Cahn (1922) conducted the first bird survey for Bird Island and documented 68 species on the island. Medoza and Ortiz (1974) examined the vegetation, bird populations and soils of 11 spoil bank islands in the upper Laguna

Madre. They conducted soil analyses and created checklists for the plants and birds found on the sampling sites.

The National Audubon Society's Christmas Bird Counts, a long-term monitoring program designed to monitor the status and trends of avian populations in North America, were conducted each December from 1975 to 1990 (National Audubon Society 2004). No surveys have been conducted since.

Anthropogenic effects

A couple of studies have documented the effects of contamination on general bird populations. King et al. (1978) examined aquatic bird eggs along the coast of Texas during 1970 and found significant decreases in shell thickness for 15 of the 22 species with DDT compounds found in all eggs. Five species in the study had declining populations. Chapman and Adams (1984) summarized data collected on coastal bird populations before and after the IXTOC I oil spill. They discussed the seasonal fluctuations in habitat and species distribution and documented the daily natural history of many of the species that inhabited the park.

Shorebirds, wading birds

General surveys

Hildebrand and Blacklock (1967) used aerial and ground surveys to conduct a colonial waterbird census along the Texas Coast, which included PAIS. Twenty-two species of colonial birds were found on PAIS from 1973 through 1990 (Author unknown n.d.). Kohlhaas (1985) examined the accuracy and relationship of four census techniques (nest, ground, aerial and photo counts) for 16 species of colonial nesting waterbirds in Laguna Madre. She found that aerial and photo counts provided inaccurate estimates because cryptically colored species or those that nested within vegetation were often overlooked. Nest counts provided the most accurate estimates. Since 1967, The Fish and Wildlife Service has conducted an annual colonial waterbird census along the Texas Coast during the last two weeks of May, in which all birds have been counted on the islands (D. L. Echols, personal communication, 12 March 2004).

Surveys have been conducted for two weeks during the past four summers along the Gulf Beach to estimate the fledging success of Least Terns (*Sterna antillarum*) and Snowy (*Charadrius alexandrinus*), Piping (*Charadrius melodus*), Semi-palmated (*Charadrius semipalmatus*) and Wilson's (*Charadrius wilsonia*) Plovers (Unpublished; D. L. Echols, personal communication, 12 March 2004). During 2002 and 2003, PAIS staff worked with Texas Parks and Wildlife to survey all four species of plovers that occur on the island, but efforts were focused on Snowy Plovers (D. L. Echols, personal communication, 12 March 2004). Starting in the summer of 2004, PAIS staff will work with the Audubon Society to replicate Zdravkovic's 2003 South Padre Breeding Season Report (D. L. Echols, personal communication, 12 March 2004).

Species distribution

Nicholls (1988, 1989) conducted a study to determine the distribution of wintering Piping Plovers along the Atlantic and Gulf coasts, with 12 of the 176 sites on PAIS and a number of others on Mustang Island, Corpus Christi Pass and Laguna Madre. She examined the wintering ecology, density and sites. Site microhabitats were analyzed and criteria were discussed to predict populations in a given habitat. She also discussed nine other wintering bird species in the area as they relate to feeding guilds.

Zonick and Ryan (1993) studied the winter ecology of Piping and Snowy Plovers along the Texas Coast. Piping Plovers were documented at higher densities along the upper portion of the coast but Snowy Plovers did not vary. Piping Plovers generally appeared dominant over both Snowy and Semi-palmated Plovers. Prey densities and foraging efficiency in multiple habitats were discussed.

Gorman and Haig (2002) determined breeding and winter distributions for Snowy Plovers using a number of publicly available datasets, published and unpublished accounts. Wintering densities were highest in the Laguna Madre.

Zdravkovic (2003) conducted the first comprehensive census of Snowy and Wilson's Plovers along south coastal Texas. General breeding ecology and distribution data were collected.

Habitat use

Withers (1994) examined the relationship between shorebird and macroinvertebrate abundance and distribution in the Laguna Madre adjacent to PAIS. Shorebirds were shown to have a significant effect on macrobenthos abundance. Presence or absence of the 22 shorebird species was not useful in predicting which habitats were critical.

Brush (1995) discussed the habitat use of various wintering shorebirds along lower Laguna Madre. Garza (1997) examined the non-breeding habitat use of Piping Plovers on South Padre Island. He found that Piping Plovers foraged on the mud flats and roosted on sand flats on the bay side of the island.

Fernandez (1999) conducted a habitat use and migration chronology study on the coast of Laguna Madre at the Laguna Atascosa National Wildlife Refuge. An average of 22 species of shorebirds was documented each winter-spring field season. These shorebirds foraged primarily in sparsely vegetated areas with shallow water or wet mud.

Drake (1999a) and Drake et al. (2001) conducted a telemetry study of non-breeding Piping Plovers along Laguna Madre. Home ranges, core areas and movement varied with the season. Algal flats were heavily used during spring and fall, and exposed sandflats were used more often in the winter. Non-breeding mortality was low during the study. In a concurrent study Drake (1999b) examined the time allocations of two plover species, which over winter sympatrically along Laguna Madre. Time allocations varied between seasons for a species and between species within a season for Piping Plovers and Snowy Plovers.

Brusati et al. (2001) examined multiple natural and created wetlands in the Aransas National Wildlife Refuge, Nueces River Delta, and Mustang Island, to compare the abundance, behavior and availability of prey for shorebirds. Differences were larger between seasons than between natural and created sites.

Reproduction

McMurry (1971, 1972) conducted a study examining Reddish Egret (*Egretta rufescens*) nesting behavior and success on spoil islands in Laguna Madre. She detailed basic breeding and nesting behavior and parameters. Simersky (1972, 1971) compared the nest success and site selection of four heron species, Snowy Egret (*Egretta thula*), Reddish Egret, Louisiana Heron (now Tricolored Heron; *Egretta tricolor*) and Great Blue Heron (*Ardea herodias*), on four spoil islands in Laguna Madre. She found that the presence of people and the addition of spoil to the islands during the incubation and early nestling stages negatively affected their nesting success. Great Blue Herons had the only stable population between years likely due to their resident status.

Depue (1974) conducted a study on the breeding ecology of the Black Skimmer (*Rynchops niger*) on spoil islands of PAIS during 1972 and 1973. He documented the reproductive activity at the nest, site selection, general biological parameters of the nest, eggs and young, and provided management recommendations and ideas for future studies. During this study, Depue also examined the use of these islands by other species of birds.

Mrazek (1974) studied the effect fire ant (*Solenopsis geminata*) colonies had on bird nests on two spoil islands in Laguna Madre. The effect fire ants had on the nesting success varied by species. Fire ants have little or no effect on Cattle Egret (*Bubulcus ibis*), Black Skimmer, Gull-billed Tern (*Sterna nilotica*) and Reddish Egret nests, but had a significant impact on the nesting success of Louisiana Heron, Snowy Egret, Laughing Gull (*Larus atricilla*) and Great Blue Heron.

Chaney et al. (1978) conducted a study on spoil islands in Laguna Madre to examine soils, vegetation and animal populations, use by seabirds and wading birds, and compared avian nesting sites with 'natural' sites on the coast.

Mitchell and Custer (1986) conducted a study on a colony of Caspian Terns (*Sterna caspia*) in lower Laguna Madre to examine hatching success. They found similar or higher rates compared with other colonies in the area.

Sims et al. (2002) documented the current vegetation and physical characteristics of the islands and listed ecological requirements for colonial waterbird nesters found on these islands.

Gene Blacklock conducted a study on the fledging success of birds that utilized dredge material islands within PAIS during 2003 and 2004 nesting season. The study focused on Great Blue Herons but also included data on additional species such as Roseate Spoonbills (*Ajaia ajaja*), Great Egrets (*Ardea alba*), Little Blue Herons, and Tricolored Herons (D. L. Echols, personal communication, 16 September 2004)

Anthropogenic effects

Custer and Mitchell (1991) examined Willet (*Catoptrophorus semipalmatus*) carcasses collected from agricultural drainages for contamination by organophosphates and trace minerals. Although detections of the various chemicals and minerals were found in the birds, all concentrations were below known toxic levels.

Mora (1996b) collected eggs from four species of wading birds in the lower Laguna Madre and tested them for organochlorine compounds and trace metals. Although 10 heavy metals were detected in 90% of the eggs, levels were not high enough for concern. The DDE levels of the current study were lower than those detected during the 1970's and 1980's. Mora (1996a) also examined the levels of polychlorinated biphenyls (PCBs) of the wading bird eggs and found that the levels were correlated with the diets of the birds. PCB levels were lower than rates known to affect reproduction.

Engelhard and Withers (1997) described the effects of mechanical beach raking on birds, insects and crustacean populations in the upper intertidal zone at PAIS. The greatest effect on macrofauna was seen in the three days following the raking. After two weeks, there was no noticeable change in macrofaunal populations. Due to the importance of this area or wrackline for shorebird feeding, they recommended stopping the raking in August to allow invertebrate populations to rebound in time for fall migration.

Waterfowl

Species distribution

McMahan (1967) conducted a study to examine the diets and distribution of two duck species, Redhead (*Aythya americana*) and Northern Pintail (*Anas acuta*), which winter in Laguna Madre. McMahan (1970) reported on the diets of these two ducks plus the Lesser Scaup (*Aythya affinis*), which also winters in Laguna Madre. Stomach contents revealed that the Lesser Scaup ate mainly mollusks and Redheads and Northern Pintails fed mainly on shoalgrass.

Cornelius (1977) studied wintering Redheads and food abundance on the lower Laguna Madre. He examined vegetation composition, shoalgrass yield, mollusk populations, exploitation of the available shoalgrass in the lower Laguna Madre and the distribution of Redheads along the central and lower Texas Coast. Marsh (1979) examined the nutrition of the Redhead population in Laguna Madre and possible effects on their distribution, feeding habits and lead levels.

Muehl (1994) conducted a study to examine the distribution and abundance of waterfowl along coastal Texas. Two species, Canvasback (*Aythya valisineria*) and Green-winged Teal (*Anas crecca*), appeared to exist in higher numbers than the target goals of the Gulf Coast Joint Venture of the North American Waterfowl Management Plan.

Habitat use

Kiel (1957) examined waterfowl wintering ecology in the lower Laguna Madre. West (1969) performed a study on the carrying capacity for waterfowl in the upper Laguna Madre and other local waterways. He developed vegetation maps, created permanent vegetation transects and conducted an inventory of aquatic flora and fauna that were important for waterfowl subsistence.

Bowles (1980) surveyed winter populations of Red-breasted Mergansers in Laguna Madre. He studied their foraging behavior, migration, sex and age ratios, body conditions, time budgets, chronology of pair formation and lead poisoning.

Mitchell (1991) and Mitchell et al. (1992, 1994) studied habitat use by Redheads on the lower Laguna Madre and examined the effects the species had on shoalgrass populations. Redheads favored lower salinity areas where they consumed more than three-quarters of the shoalgrass rhizome biomass each year and kept it below its maximum biomass. Custer et al. (1997) examined the wintering ecology of Redheads in Laguna Madre. Redheads occupied shoalgrass beds at a higher rate than it occurred in the environment. Bart Ballard, a researcher from A&M Kingsville, also has been studying the effects of Redheads on seagrasses during the winter period for the past couple of years (D. L. Echols, personal communication, 12 March 2004).

Woodin (1994) studied habitat use of wintering Redheads in Laguna Madre. Both freshwater and saltwater habitats were important for drinking and feeding, respectively.

Anthropogenic effects

Singleton and Kiel (1957) conducted a study to examine the effects that the construction of the Padre Island Causeway had on the duck and aquatic plants in the upper Laguna Madre and Corpus Christi Bay. Using surveys, maps and salinity records they determined that the Causeway had little effect on these populations except to increase silting in the area.

McMahan and Fritz (1967) conducted a survey to determine the extent to which trotlines injured ducks in the lower Laguna Madre. Laguna Madre is an important wintering ground for Redhead and Northern Pintails but it is also heavily used by commercial and recreational fisherman. Trotlines have become a dominant form of fishing in the area because gill netting became illegal. McMahan and Fritz estimated that over 20 thousand Redheads were killed during the three month period the birds were in the area.

Michot et al. (1994) examined Redhead carcasses for organochlorine, hydrocarbon and trace element contamination but found either no residue or residues below toxic levels in all samples. DDE was the only organochloride detected and it was below reported toxic levels.

Pelicans

General surveys

Sloan (1982, n.d.) reported population estimates for White Pelicans (*Pelecanus erythrorhynchos*) on South Bird Island, Laguna Madre and Aransas National Wildlife Refuge from 1963 to 1979. Surveys for pelicans also have been conducted along the Texas Coast as a part of the Fish and Wildlife Service's Colonial Waterbird Census and the four year-long general surveys conducted on PAIS (D. L. Echols, personal communication, 12 March 2004; Chaney et al. 1993, 1995a& b; Ecoservices 1993).

Reproduction

Carroll (1930) conducted a survey of nesting White Pelicans on Bird Island, Laguna Madre and PAIS during 1926-1929. In a 1985 report, Chapman discussed the results of a study on the effects of ectoparasites on White Pelicans in colonies at PAIS (Chapman 1985). Chapman (1988) described the historical breeding population of White Pelicans on PAIS. Since 1907, the breeding population in South Texas has generally remained around 200-500 nests although there have probably been some extreme years. Occasionally a colony was established then abandoned despite having eggs or young. Predator disturbance and brood reduction were considered the more likely explanation for abandonment than the previously thought ectoparasites and storms.

Anthropogenic effects

King et al. (1977) discussed the population decline of the Brown Pelican (*Pelecanus occidentalis*) nesting in Corpus Christi Bay from 1918 to 1964. King et al. (1978) described the effects of pesticides on the reproduction of Brown Pelicans and a number of wading birds along the Texas Coast. Populations of some species were particularly affected in Laguna Madre.

Raptors

Habitat use

Peregrine Falcons

Padre Island National Seashore is a major staging area for migrating Peregrine Falcons for feeding and resting. Hunt et al. (1975) reported on observations of Peregrine Falcons in PAIS during fall migration. They discussed the density and diversity of the population as well as prey and hunting strategies as they related to characteristics of the wintering grounds.

An extensive effort to monitor Peregrine Falcons on PAIS was initiated during 1977. Fall and spring migrants were observed and trapped, banded and bled to test for pesticides and genetic markers. Information was summarized on a seasonal or yearly basis with a 10-year summary of the project written in 1988 (Bjork 1988). Ward and Riddle (1978) and Ward (1979) conducted a study of migrating Peregrine Falcons on Mustang Island and North Padre Island during 1977 and South Padre during 1977 and 1978. Anderson (1980) discussed the ecology of the Peregrine Falcon during spring migration as it passed through South Padre Island. Hunt et al. (1980)

examined habitat selection and utilization by these migrants using radio telemetry. Hunt et al. (1980, 1981) described spring migration patterns of 24 Peregrine Falcons during 1979-1980 at PAIS and the surrounding area as they migrated from South America to the Arctic. They conducted an analysis of the habitat used during this period. Ray et al. (n.d.) conducted aerial surveys of migrating Peregrine Falcons during spring of 1981 from Corpus Christi Texas to Vera Cruz, Mexico. They found that the highest concentrations were on large wind-tidal flats over beach and dune, similar to Padre Island. They found three such areas along the Gulf Coast of Mexico. Maechtle (1988) discussed spring and fall Peregrine Falcon surveys conducted during 1988 at PAIS. Larrabee and Lepisto (1993) studied the wintering behavior of Peregrine Falcons though the use of radio telemetry on birds that were caught during migration on South Padre Island and Laguna Madre. Due to the effect the monitoring was having on other species, the project was discontinued on PAIS after the fall of 1993, but monitoring still occurred outside of the park after this period (D. L. Echols, personal communication, 12 March 2004). Chavez et al. (1994) used radiotelemetry to track the migration of fall and spring migrating Peregrine Falcons departing from PAIS. They examined flight speeds and times as well as distances traveled. Enderson et al. (1995) examined habitat use of wintering Peregrine Falcons in Laguna Madre. Tidal flats and shallow water were the most frequented habitats with extensive overlap between individuals. Fuller et al. (1998) examined the migration patterns of tagged Peregrine Falcons and Swainson's Hawks using the Argos satellite system. Speeds, distance traveled, locations and duration of migration were discussed.

Burrowing Owls

Jones (1999) conducted transect surveys to examine the Burrowing Owl (*Athene cunicularia*) population on northern PAIS. She found 65 burrows or 6.2/ha although none were thought to be active, but no owls were detected. Williford (2003) studied the winter roosting sites of the Burrowing Owl in South Texas. Most roost sites were found in agricultural lands although this may reflect a bias towards the inaccessibility of private grasslands to the general public. Burrowing Owls were reported foraging along the road in PAIS and one roost site had been located. More sites might be found within PAIS with a greater search effort. Ortega (2003) examined the use of artificial burrows during the winter at four sites in South Texas. She found that Burrowing Owls preferred the smaller diameter burrows among those available. Diet analysis found that mammal remains were more common in the pellets of barrier island owls than grassland owls. USGS-BRD, Corpus Christi, conducted a project that examined Burrowing Owl use during the winter of 2003 of two artificial burrows installed at the park (D. L. Echols, personal communication, 16 September 2004).

Anthropogenic effects

Ward et al. (1978) collected blood samples from Peregrine Falcons that migrated through South Padre Island during the spring and examined their pesticide contamination levels. Hunt et al. (1979) conducted a study on the migratory patterns of Arctic Peregrine Falcons that were banded and fitted with radio transmitters at PAIS. Blood samples from these birds were tested for concentrations of pesticides ingested in their Meso and South American wintering grounds. Henny et al. (1982) tested the blood of Peregrine Falcons during spring and fall migrations on Padre Island from 1976 to 1980. They found that organochlorine pesticide (DDE) from the Latin

American wintering grounds was accumulating in the birds but this threat began to lessen in 1979. They collected additional samples in 1984 and compared those with the 1982 study (Henny et al. 1985). In a later survey, Henny et al. (1996) found a continuation of the DDE reduction. No other residual organochlorine pesticides previously detected were found in the 1994 samples. However, three-quarters of the females caught in 1994 had detectible levels of PCBs.

Maechtle (1991) used data from trapping and banding, re-sightings and returns, blood samples and pesticide contamination records at PAIS to estimate population trends for Peregrine Falcons. Data suggested that Arctic populations may be recovering.

Songbirds

General surveys

Mist net surveys have been conducted on Padre Island almost every year since 1993 (D. L. Echols, personal communication, 12 March 2004). Smith (2000) described the banding efforts for Neotropical migrants that occurred on PAIS during 2000. Unlike previous years, this effort was confined to weekends instead of in conjunction with southward moving fronts. Forty-five species were documented during this period and a total of 89 species have been documented since 1996.

Species distribution

Lasley et al. (1982) documented sightings of the Red-faced Warbler in several areas in Texas including PAIS. The report discussed the sightings as they relate to migration patterns into New Mexico.

Habitat use

Blacklock et al. (1997, 1998) conducted mist net and line transect surveys during 1997 and 1998 on PAIS. Mist nets were placed in wetlands and dunes and line transects sampled burned and unburned portions of these two habitats plus grasslands. During both years they documented a greater abundance of migrants in the unburned areas and more residents in the burned area. More birds were trapped in the wetland habitat than the dunes during 1998 only.

Experts: Allan Chaney (Ecoservices; retired dean of A&M Kingsville), Kim Withers (Texas A&M University-Corpus Christi), Gene Blacklock (Coastal Bend Bays and Estuary Program; Ecoservices)

FISH

Although there have been no large scale fish surveys conducted by PAIS almost 150 species of fish have been documented at the park. Texas Parks and Wildlife have monitored finfish in the

area for an extended period. A literature compilation relating to finfish in the area and an annotated species list is expected (D. L. Echols, personal communication, 12 March 2004). Fish species in the open waters have been well documented due to the high concentration of commercial and sport fishermen in the area. Those species located inland have not been well studied.

General Surveys, Checklists

McFarland (1963) sampled fish seasonally around Mustang Island. He documented 47 species, most of which fed on plankton. Mean total biomass captured varied with season from a low of 25.8 pounds in the winter to 103.2 pounds in the summer. He found that winter also coincided with the lowest plankton productivity.

In a year-long study, Copeland (1965) sampled the fish population that passed through Aransas Pass inlet. Fifty-five species were collected in tide traps throughout the year with the greatest number of individuals captured in May through June and in October.

Miller (1965) conducted a survey of the fish species captured during the bi-monthly trawls off of Port Aransas and documented 68 species. He also estimated the spawning season based on the quantity of juveniles in the catch.

Causey (1969) examined the fish population associated with Seven and One-half Fathom Reef, located 4 kilometers east of PAIS in the Gulf of Mexico. He identified 87 fish species, their densities, distributions and the variations that occurred, depending on changes in hydrology. Thirteen of these species were not previously documented in the Northwestern Gulf.

Shaver (1984) examined the fish and plankton at PAIS during 1982 and 1983. She documented 6 species that had not previously been detected in the Gulf Coast waters. Shaver (1989) conducted a 17-month study examining the baseline fish and plankton populations for PAIS. She documented species and abundance of surf fish as well as information on migration patterns, size, growth, seasonal variations and relationship between inshore plankton and fish. No long-term effect of red tides was seen on fish populations. She documented 62 fish species, 42 types of plankton and 35 invertebrate species. Chaney (1988) also collected data on the fish and plankton populations for this report. His sampling occurred in the Laguna Madre and Shaver collected data in the Gulf.

In a benthic community study of the gulf beach of PAIS, Rocha (1995) also sampled the fish populations within the area.

Hoese (n.d.) created a summarized list of the fish species detected in the marine waters off the coast of Texas, including PAIS regions. The list documented over 400 species and included the understudied area of the waters beyond the 1000 fathom line.

General studies - Marine, Estuary, Bay

Abundance

Springer and Pirson (1958) reported a sharp decline in the number of fish caught during 1955-1956 as compared to 1952-1954 in Port Aransas. They did not address a cause for the decline. Moore (1975) discussed a correlation between six tropical marine fishes and sea water temperature at Port Aransas. He found that the species occurred at higher rates as the temperature of the water increased.

Breuer et al. (1977) studied the fish harvest of recreational and commercial fishermen from the Gulf of Mexico, including Corpus Christi Bay and lower Laguna Madre. They summarized data based on location, quantities and species.

Bryan and Cody (1978) conducted a survey on the seasonal abundance of shrimp and fish off the coast of PAIS. They also examined catches from inshore shrimp trawls to determine the most abundant finfish in the catches. They found Atlantic croaker (*Micropogon undulates*), silver seatrout (*Cynoscion nothus*) and sand seatrout (*C. arenarius*) were the most abundant. In the last part of the study they examined the used of large-mesh trawling for commercial fishing. They listed six species that had the highest potential for commercial use, with black drum (*Pogonias cromis*) being the most abundant species. They included environmental parameters such as season, weather, water temperature and turbidity as well as species and abundance in their study.

Matlock and Weaver (1979) conducted an 8-month survey of five finfish in the bays in the Texas Gulf Coast, including Corpus Christi and upper and lower Laguna Madre. These fish made up 97% of commercial fishermen's total catch in the area. Parker and Bailey (1979) discussed major aggregations of Elasmobranchs near Mustang and Padre Islands.

McEachron (1980a&b) described the findings of the first two years of a 5-year study (1977-1982) of the finfish catches in the Gulf of Mexico. Areas sampled included those off the shore of PAIS and upper and lower Laguna Madre, among other local waters. This data will be used to predict total harvest for the area.

Lacson and Lee (1997) conducted a study on the relative abundance of six finfish, including red drum, spotted seatrout, black drum, Atlantic croaker, Southern flounder (*Paralichthys lethostigma*), and Gulf menhaden (*Brevoortia patronus*) in the CCBNEP study area, which includes the upper Laguna Madre. They estimated relative abundance using data from otter trawl samples from 1982-1993 and bag seine and gill net samples from 1976-1993. They also created maps that depicted the relative abundance spatial throughout the study area.

Ecology

Hellier (1962, 1961) examined the relationship between photosynthetic plant production and growth rate of fish in Laguna Madre. Fish biomass was determined using drop-net quadrant and plant production was measured using a diurnal oxygen method. A correlation was found between fish biomass and gross plant production.

During a study on the echinoderm species of Seven and One-half Fathom Reef, Shirley (1974) conducted a content analysis on 31 species of predator fish and found that the fish fed heaviest on the most abundant echinoderm species.

Henley and Rauschuber (1981) conducted a study to examine the freshwater needs of the fish and wildlife in the Nueces-Corpus Christi Bay. The purpose of the study was to develop a water management plan to insure that the proper level of freshwater was supplied.

Persistence of unseasonably cold temperatures during the Fall of 2000 caused a large kill of hardhead catfish (*Arius felis*) in the Laguna Madre (Author unknown 2000).

Reproduction

Hensley (1986) examined the reproduction of longnose killifish (*Fundulus similis*) populations found in the lower Laguna Madre.

Kucera et al. (2002a) examined the effect of salinity on the eggs and larvae of the spotted seatrout (*Cynoscion nebulosus*) and found it was dependent on the spawning salinity of the adults and the salinity of the bay. Kucera et al. (2002b) examined the effect of salinity on eggs and found a significant effect on egg diameter but not at the time of hatch. These studies suggested the fish were adapted to local conditions.

General studies - Inland

Caudle (1992) studied the population dynamics of mosquitofish (*Gambusia affinis*), sheepshead minnow (*Cyprinodon variegatus*), and Gulf killifish (*Fundulus grandis*), in three earthen ponds on north PAIS. He examined abundance, recruitment, size class progression and tolerance to salinity. In a related study of these three freshwater ponds, Sissom et al. (1990) collected and summarized data on the biotic community, including fish.

Experts: John Tunnell (Texas A&M University-Corpus Christi), Allan Chaney (Ecoservices; retired dean of A&M Kingsville), Liz Smith (Texas A&M University-Corpus Christi), David Hicks (Texas A&M University-Corpus Christi)

INVERTEBRATES

No comprehensive studies of the invertebrate populations of PAIS have been conducted. Instead, information has been gathered by site specific or population specific studies and has covered a wide variety of species and habitats.

Collections

According to NatureBib records, there are a number of collections of invertebrates taken from PAIS or the surrounding area. Many of these are housed in the PAIS museum. One such collection consists of 22 arthropods from PAIS collected between 1961 and 1981 (Padre Island National Seashore 1966). A second collection of invertebrates from PAIS and Mustang Island contains 66 species accrued between 1969 and 1992 (Padre Island National Seashore 1969). An additional collection of over 400 insect species from PAIS and Port Aransas was made from 1965-1979 (Padre Island National Seashore 1965). There was also a collection of 983 specimens of marine seashells that was made during 1964-1980 on PAIS and Mustang Island (Padre Island National Seashore 1964).

Terrestrial

General surveys, checklists

Blanchard (1976a&b) described multiple new species of Lepidoptera that were discovered on PAIS. In a survey at the park, Blanchard (1979a&b) documented 16 and 43 species of moths collected during May and September of 1979, respectively, at PAIS. Blanchard and Knudson (1984) described a new noctuid moth (*Stibadium caesium*), which again was located at PAIS. In a later report, they described 28 moth species generally found for the first time in Texas or the U.S. These species were located in a number of national parks including PAIS.

McDaniel and Bolen (1979) described the discovery of *Micromegistus bakeri* Tragardh and three species of beetles found in the same soil sample on PAIS. The discovery of *M. bakeri* was a new distribution record for the species. In a following article, McDaniel and Bolen (1981) described the discovery of a new genus and two species of Nanorchestidae mites on the foredunes of PAIS.

Burke et al. (1991) discussed the beach-drift insects found on PAIS after the passage of a front. The assemblage was composed of 11 species and largely made up of locally distributed Coleoptera and Hemiptera.

R. Nelson (1997) conducted a robber fly survey on PAIS to determine if historically recorded species were still present. She found abundant populations of one of the species previously documented on Padre Island.

In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community including the terrestrial arthropod populations.

Charlie Sassine is currently conducting a butterfly survey of PAIS and will provide baseline data for the park (D. L. Echols, personal communication, 12 March 2004). According to the PAIS website, 42 species have been documented (Padre Island National Seashore 2004).

Ecology

Mrazek (1974) studied the effect fire ant colonies had on bird nests on two spoil islands in Laguna Madre. They located over 150 fire ant colonies during the avian breeding season each year. Mrazek described the kinds and quantities of adults from one excavated colony. Basic ecology of the ants, the effect they had on nesting birds and the effect of Sevin, a pesticide, as a deterrent also were described. The Texas Agricultural Experiment Station and Texas Department of Agriculture (1980) conducted studies on the Imported Fire Ant infestation at PAIS.

Neck (1989) detailed the ecology of the terrestrial dune snail, *Succinea-paralia* Hubricht, on South Padre Island.

Anthropogenic effects

Ortiz (1976) conducted a study on the effect of human activity on the insects on Padre Island. Wicksten et al. (1987) collected baseline information on invertebrate populations inhabiting two beaches that varied in the amount of traffic they received. They examined the diversity and distribution of species, effect of seasons and physical parameters such as tides, temperatures, salinity, foredune growth, traffic and weather.

Engelhard and Withers (1997) described the effects of mechanical beach raking on birds, insects and crustacean populations in the upper intertidal zone at PAIS. The greatest effect on macrofauna was seen in the three days following the raking. After two weeks, there was no noticeable change in macrofaunal populations.

Aquatic - Benthic

General surveys, checklists

Tunnell and Rocha (1993) conducted a study to examine the abundance and distribution of infaunal species that inhabit sandy beaches on PAIS. They surveyed four sites, each of which was in a different type of sand formation.

In a study on the effects of Red Tide on surf zone fish and plankton, Shaver (1989) found 35 species of invertebrates.

Wicksten et al. (1990) collected core samples of benthic invertebrates from sites on northern and southern Bird Island Basin (BIB). Sites varied in the quality of the animals collected, with season and climate also affecting samples. They recorded species, density and location, created an erosion map and conducted an analysis of sand grain size.

Withers (1994) examined the relationship between shorebird and macroinvertebrate abundance and distribution in the Laguna Madre adjacent to PAIS. Over 50 species of macrobenthos were documented. Higher densities were found in soil depths less than 5 cm but biomass was often higher between 5-10 cm.

Rocha (1995) examined PAIS's Gulf beaches to collect baseline data on the benthic invertebrate communities. Basic information on abundance, biomass, species composition and diversity was collected. He found three well defined distribution zones: the backshore, the intertidal and the subtidal bar/trough zones.

Distribution

Hill (1974) examined the macrobenthos zonation that occurred on the inner shelf of PAIS. He described the dominant species found for each of the areas: nearshore bar and trough, shoreface, sandy substrates, muddy substrate and the transitional zone between sandy and muddy. In a later study, Hill and Hunter (1979) described the distribution of macroinvertebrates found in Quaternary shell beds on north Padre Island.

Staff (1983) and Smith (1985) examined past macroinvertebrate populations using death assemblages.

Anthropogenic effects

Withers et al. (1995) collected benthic invertebrate samples from intertidal and subtidal areas along PAIS to determine if the *M/T Berge Banker* oil spill or cleanup had any effect on abundance or community structure. Changes in community structure were detected for some areas sampled, likely due to cleanup, but were not expected to be long-lived.

Engelhard and Withers (1997) described the effects of mechanical beach raking on birds, insects and crustacean populations in the upper intertidal zone at PAIS. The greatest effect on macrofauna was seen in the three days following the raking. After two weeks, there was no noticeable change in macrofaunal populations.

Aquatic - Crustacean

General surveys, checklists

Shirley (1974) discovered a crab species (*Planes cyaneus*), which has never been documented in the Gulf of Mexico, in a rarely sampled portion of PAIS. It was unknown if this was a rare occurrence or if the crab has a wider range than what was previously known.

Ecology

Powell and Gunter (1968) conducted a study on the general ecology and behavior of the stone crab (*Menippe mercenaria*), the only *Menippe* species found in Texas waters. The study was conducted near Port Aransas and examined their spatial and size distributions, densities, daily and breeding activities and food habits and other organisms in crab burrows.

Pitakpaivan (1988) examined sediments of Baffin Bay and found a low diversity in the foraminiferal and ostracodes assemblages. Sixty percent of the ostracodes assemblages were

represented by four species. He proposed that the fluctuations in salinity create an unstable high stress environment that resulted in the low diversity.

Guerin and Stickle (1992) studied the effect of salinity levels on growth and energetics of juvenile blue crabs from two habitats that differed greatly in saline content. Peak growth occurred at levels similar to their normal environment and maximal energy occurred at higher salinity levels for crabs from the hypersaline environment.

Distribution

Felder (1971) studied the species present, density, distribution and seasonal variation of decapod crustaceans found on Seven and One-half Fathom Reef.

Hill and Hunter (1973) discussed how the shape, diameter, length, orientation and density of ghost crab (*Ocypode quadrata*) burrows help to identify environments on the beach, foredune and backshore areas of PAIS. Rabalais (1976) listed the crabs found in four habitat zones on PAIS: offshore, shallow water, terrestrial and Laguna Madre.

Anthropogenic effects

Teerling (1970) conducted a study of the effect of human activity, weather and season on the density and activity of ghost crabs on the forebeach of PAIS. She found that greater densities of ghost crabs occurred in areas with less people.

Baccus and Horton (1979) studied the effect of vehicular traffic on the crustacean population on the beach-foredune habitat of PAIS. They found that the traffic had direct (mortality) and indirect (compaction of the soil) effects on ghost crab populations. Possible ecological implications of a large-scale population reduction also were discussed.

Engelhard and Withers (1997) described the effect of mechanical beach raking on birds, insects and crustacean populations in the upper intertidal zone at PAIS. The greatest effect on macrofauna was seen in the three days following the raking. After 7-10 days, density and biomass of an amphipod, the common marsh hopper (*Orchestia grillus*) was still lower at the raked sites. After two weeks, there was no noticeable change in macrofaunal populations.

Aquatic - Mollusks

Surveys, checklists

Tunnell and Chaney (1970) and Tunnell (1969, 1973) conducted surveys for mollusks and found 169 species on Seven and One-half Fathom Reef. Thirty-seven of these species were new records for the coast of Texas. Tunnell (1977) constructed a list of 28 mollusk species that were collected from PAIS from four sites during a biology field trip. Woods (n.d.) inventoried the mollusk population on to north jetty at Port Mansfield Channel and documented 29 species.

In a baseline study of three freshwater ponds on PAIS, Sissom et al. (1990) collected and summarized data on the biotic community including the mollusk populations.

Ecology

Loesch (1957) studied two species of *Donax* (i.e., *D. variabilis roemeri* and *D. tumida*) on Mustang Island. He examined the habitats, predators and parasites, seasonal changes and the physical differences between the two species.

Williamson (1980) examined mollusk populations inhabiting seagrass beds in upper Laguna Madre to determine the effect of seasonal changes. Bivalve and gastropod populations were affected by changes in temperature and salinity.

Martinez-Bucciantini (1995) examined pure and cross-bred progeny of two distinct oyster populations from Offatt's Bayou and lower Laguna Madre. Survival was highest in pure crosses and there was a correlation between larval size and metamorphic success. Survival rates were higher in Laguna Madre. King et al. (1994) examined nine populations of oysters in Laguna Madre and found two genetically distinct groups and multiple transitional groups. He recommended that these populations be managed as individual units. Bushek and Allen (1996) examined offspring from four populations of oysters for resistance to the parasite *Perkinsus marinus*. Resistance was correlated with the amount of time the adults were exposed to the parasite.

Montagna et al. (1993) examined the effect of the brown tide on the dwarf surfclam (*Mulinia lateralis*) to determine if the population decline was caused by the brown tide onset. The brown tide did not affect grazing or assimilation rates so a negative trophic effect was not implicated but other reproductive or toxic effects of the brown tide may have played a role.

Hicks et al. (1998) studied the environmental physiology of the bivalve (*Perna perna*) off of Aransas Pass and the Gulf of Mexico. He described the ecology of the species and its tolerances to environmental pressures such as temperature and salinity.

Distribution

Behrens and Watson (1969) examined the waves and currents responsible for the predominance of either left or right valve Pelecypod on beaches. They found there was a complex system of currents that produced sorting and the oblique wave action was the primary force for this sorting.

Vega (1985) conducted a study to examine the density and distribution, as well as migratory behavior, growth rates, spawning periods and dispersal of two species of *Donax* (*D. variabilis roemeri* and *D. v. texianus*) found on Mustang and Padre Island.

Other Aquatic Invertebrates

General surveys, checklists

McCarty (1974) conducted a study on polychaetes found on Seven and One-half Fathom reef and created a list of 88 documented species.

Shirley (1974) examined the echinoderm species that existed on Seven and One-half Fathom Reef. He documented 26 species of echinoderms including 8 new species. Diet analysis of 31 species of predator fish found that the fish fed heaviest on the most abundant echinoderm species.

Hess (1978) conducted a study on the shallow-water asteroids (starfish) of the Gulf of Mexico. He examined the species and habitats that existed in the shallow-waters off PAIS.

Abundance

Lacson and Lee (1997) conducted a study on the relative abundance of finfish and four macroinvertebrates, including white (*Penaeus setiferus*), brown, and pink (*P. duorarum*) shrimp, and blue crab, in the CCBNEP study area, which includes the upper Laguna Madre. They estimated relative abundance using data from otter trawl samples from 1982-1993 and bag seine and gill net samples from 1976-1993. They also created maps that depicted the relative abundance spatial throughout the study area.

Ecology

Johnson (1963) conducted a study on the juvenile shrimp populations found in the lower Laguna Madre. Stokes (1974) described the results of a study that examined brown, white, and pink shrimp populations in the lower Laguna Madre, including their abundance and the effect of ecological factors on the population.

Fairchild (1985) conducted a study on sea urchins off South Padre Island.

Strenth and Blankenship (1991) studied the seasonal abundance and reproductive patterns of the sea hare (*Aplysia-brasiliana rang*) at South Padre.

Pitakpaivan (1988) examined sediments of Baffin Bay and found a low diversity in the foraminiferal and ostracodes assemblages. Seventeen species of foraminiferal were found in samples, but one species (*Ammonia parkinsoniana*) made up 75% of the population. He proposed that the fluctuations in salinity created an unstable high-stress environment and resulted in the low diversity. Stewart et al. (1994) examined core samplings from the hypersaline Baffin Bay. The bay contained a late Holocene paleo-environmental record due to the increased salinity of the water that created laminated sediment preservation. They found three major taxonomic groups of Foraminiferal assemblages within the core samples. The effect of environmental conditions on dominant species was discussed.

Anthropogenic effects

Stickle and Zhang (2003) examined the instance of imposex in *Stramonita haemastoma* populations in the Gulf of Mexico and Florida from 1988 to 2000. This development of a penis and vas deferens in the female was caused by an antifouling chemical, Tributyltin, which had been banned in the US since 1988. Initial levels were high of South Padre Island but declined over time.

Experts: Kim Withers (Texas A&M University-Corpus Christi), John Tunnell (Texas A&M University-Corpus Christi), David Hicks (Texas A&M University-Corpus Christi), Paul Montagna (University of TX, Marine Science Institute)

PHYSICAL RESOURCES

GEOLOGY

A number of documents describe the general geology of the island and the area, including some specific to the park. Studies have also focused on the transportation of sediment through wind and water and the resulting effects on this barrier island.

Formations

Arnberger (1958) described PAIS before it became a national park. She discussed the geology of the barrier island and described the biological and environmental features as well as the surrounding marine actions.

Fisk (1959) described the geologic formation of Padre Island (including Mustang Island), Laguna Madre and the Laguna Madre Flats. The source of the sands (Rio Grande from the south and Brazo, Colorado and other smaller rivers from the north) as well as the force that have transported them (longshore gulf currents, waves and wind) to the island and flats also were described.

Maxwell et al. (1970) described the underlain formation of Padre Island as an ancient barrier bar deposited during the late Pleistocene period. The sediments deposited on this barrier were of the Quaternary Period and were formed during the Recent Epoch. They primarily consist of sand and shell. The park is contained within the Gulf Coastal Plain.

Hill and Hunter (1976) described the biological and geological processes that affect the marine and shore environment at PAIS.

Weise and White (1980) described the geology, natural environments and history of PAIS. Harris and Kiver (1985) described the geologic history of the Coastal Plain Province, which includes PAIS. They discussed two possible sequences of events that could have created Padre Island.

The Gulf Coast Association of Geological Societies produced a field guide from a convention field trip in 1972 (Gulf Island Association of Geological Societies 1981). Within this guide, Hunter et al. (1981) described the general geology of PAIS as well as provided descriptions for each of the field trip stops along the Gulf Shore beach.

Tunnell and Judd (2002) described the geology, hydrology and ecology of the system. They discussed multiple ecosystems in the estuary including seagrass meadows, open bay, wind-tidal flats and barrier islands, and the organisms that inhabit them.

Soil, sediment

General area

Holmes and Slade (1975) examined the sediments of the South Texas Continental Shelf and the coastal estuaries for trace elements of natural or anthropogenic origins. They found that the sediments on the upper slope had higher trace-metal levels.

Rodriguez et al. (2001) sampled sediment and collected an echo-sounding profile at 30 shoreface transects along the Texas Coast down to South Padre Island. The shoreface was made up of three general sedimentological facies, including the upper (almost entirely sand), the proximal lower (sand and thick to medium-bedded mud) and the distal lower (mud with medium to thinly-bedded sand), but varied greatly along the coast. The southern coast was composed of thin retrograding deposits.

Padre Island and surrounding area

Boker (1956) studied five types of sand dunes on Northern Padre Island. He examined dune development, migration, sedimentation and erosion, and conducted a granulometric analysis of the dune sands. He also discussed the geological history, sediment development and movement, actions of wind and tides, vegetation, creation of blowout dunes, shrub-coppice dunes, source of sand, sand composition and roundness, and surface texture.

Bradley (1957) examined the makeup of sediments on Mustang Island beach. He found that marine and subaerial sediments could be distinguished through analysis of heavy minerals, which may be useful for examining ancient sediment deposits.

Mason and Folk (1958) examined the grain size of beach, dunes and Aeolian flats on Mustang Island and found that each of the environments could be determined using size analysis.

Moyd (1958) described the segregation of heavy mineral concentrations to the extremities of Padre Island. He attributed this segregation to the strong offshore southeasterly wind and waves that create a migration of sand from the ends of the island to the center.

Parker (1959) examined the distribution of macroinvertebrate assemblages in coastal bays and Laguna Madre to develop criteria for interpreting the depositional environments of current and historic sediment. Five assemblages were documented in Laguna Madre.

McBride and Hayes (1962) took advantage of the destruction caused by Hurricane Carla to examine exposed dune cross-beds on Mustang Island. Results from this study suggested that the eolian cross-beds were not necessarily thick.

Hayes (1963) analyzed 60 dune and 16 beach samples for grain size on Padre Island. He found no difference between the two types but did find differences between the sand found on the northern and southern end of the island. Sand along the southern end was coarse and deposited by the Rio Grande. The finer sand in the north was deposited by the Nueces, Colorado and

several other rivers to the north. A transition zone exists in the middle of the island where the sand is an equal measure of the two sizes. Milling and Behrens (1966) examined the structural composition of beach and dune sediments on Mustang Island.

Dickinson and Hunter (1970) discussed how the variation in grain size on beaches of Padre Island could be explained by the way in which they were deposited. They also found that Padre Island was not a prograding island because the sand size does not decrease with increased depth.

Moiola and Spencer (1973) examined the sedimentary structure of four subfacies in the beach and dune habitat on Mustang Island. They found that grain size distribution was similar for all of the areas and could not be used to distinguish the types. However discriminant analysis could be used to separate the areas.

Davis (1978) monitored multiple beaches on Mustang and Padre Islands to determine the influence of season and geographic area on sedimentation. He found that there were three distinct geographic areas. Grain size did not vary much due to season in the southern and northern provinces, but they did in the convergence area.

Huc and Hunt (1980) examined two Tertiary sequences offshore from South Padre Island for hydrocarbon content.

Chaney et al. (1980) conducted transects on four beach areas to examine vegetation and sedimentation of the foredunes. Species composition and height of foredunes varied but no trends were found.

Morton and McGowen (1980) studied samples of the late Quaternary sedimentological record that exist on North and South Padre Island and Laguna Madre. They included the effects of weather, water (rivers and tides), deposition and accretion on the barrier island in their discussion.

Hummel (1982) conducted a study on the development, subsurface characteristics and deposits of interdunes in the back-island dune field on North Padre Island. He examined the effects of wind, moisture, and wet or dry weather on deposition, accretion, continuing migration and the amount of sediment deposited in the interdune.

Mazzullo et al. (1983) conducted a study to determine the source of the sand of North Padre Island. They examined sand from the Brazo-Colorado Rivers and the Rio Grande and found the gross grain shape of the island was only abundant in the Rio Grande. Mazzullo and Sims (1983) also examined gross and fine shape characteristics, using the Fourier shape technique, to differentiate beach and dune sands from Malaquite beach, Padre Island.

Maynard and Suter (1983) used multiple sampling methods to examine the internal structure of washover deposits on South Padre Island. The prevailing stratification found were plane beds with substantial heavy mineral laminae.

Hummel and Kocurek (1984) compared the interdunal areas at PAIS to ancient examples. They examined various attributes of the interdunal area including sand storage, deposition and accretion, size and thickness, moisture load, adhesion structures and penecontemporaneous deformation.

Russell (1987) examined Big Shell and Little Shell Beaches of PAIS. These were examples of exogenous processes deposited by the sea. They discussed the geological features, vegetation and animals of the beaches. They found differences in the distribution of sand grain size and mineralogies between the two beaches.

McBride et al. (1991) examined the formation of gypsum sand crystal in Laguna Madre and proposed that the crystal was formed through seepage reflection of the lagoonal brine.

The Natural Resource Conservation Service is conducting a soil survey specific to the park and is expected to be complete in 2004. Soil samples have been collected and are being used to determine soil types (D. L. Echols, personal communication, 12 March 2004). This will be the most comprehensive survey conducted at the park. Soil surveys have previously been conducted for Willacy, Kenedy and Kleberg Counties but were more general in nature (Soil Conservation Service 1980, 1985; Turner 1982).

Sediment Transport

Price and Kornicker (1961) examined fragments of *Mulinia lateralis* shells found imbedded in the clay dunes south of PAIS near Port Isabel. They found that wind could transport these shells from Laguna Madre, where they live, up the steep slopes and deposit them concave side down on these dunes.

Hayes (1966) conducted a study on the beaches of Padre Island before and after Hurricane Carla (1961). He found that the storm deposited shells and rock fragments from the inner neritic zone on the island. After the storm, water flowed off the island and deposited a thin layer of sand out to a depth of approximately 60 feet. A portion of foredunes from the seaward side of the island was removed and created a foredune ridge coupled with wave-cut cliffs. The resulting beaches were broad and flat and drastically different from the pre-Carla landscape. Hurricane Cindy (1963) was mild in comparison and deposited a swash bar along the seaward edge of this 'hurricane beach.'

Watson (1968, 1971) conducted a study of the shell and sand accumulation that occurs in the central portion of Padre Island due to the merging of littoral drift. He discussed the role of wind in these formations, the concentration of shells in the dune trenches, as well as how the offshore carbonated cemented rock affected shell beaches. Comparisons were also made between the mainland shore of Laguna Madre and ancient beaches.

Chafetz and Kocurek (1980) studied the beach cusp migration that created atypical foreshore deposits along Big Shell and Little Shell Beach.

McBride et al. (1996) examined the loss of sand-size feldspar and rock fragments from Padre Island. Two different forces caused the loss on the island. Loss on the northern end was due to abrasion and breakage, and an importation of more quartzose grains from the north. The southern end loss was due just to wave action.

Morton et al. (1998) examined the sediment budget analysis for Laguna Madre. They found that the total volume of new sediment was less than that of the amount dredged from the GIWW. Additionally, the level of sedimentation in the lagoon was less than the rate of sea-level rise. These reductions in sedimentation in conjunction with the erosion of the western shore, lead them to the conclusion that the lagoon was not filling up as some have said, but instead was migrating westward.

Experts: Dennis Brezina (NRCS), Todd Halihan (Oklahoma State University), John Sharp (University of Texas Austin), C. Alan Berkebille (Texas A&M Corpus Christi), Jennifer Prouty (Coastal Research Associates, Corpus Christi)

HYDROLOGY

Liz Smith and Kim Withers (Texas A&M University-Corpus Christi) are currently summarizing all information on the park's water resources. The National Park Service's (NPS) Water Resource Division will be examining the watershed for the park (D. L. Echols, personal communication, 12 March 2004).

Kaiser et al. (1993, 1995) discussed the status of water quality monitoring in 10 national parks in Texas, including PAIS, and also touched on the issues and concerns involving these parks.

Groundwater

Myers (1964) conducted a survey on the availability of potable water on the north and south ends of Padre Island. Using surveys and electric oil test logs, he found that there was not enough naturally existing potable water available on the island to support the proposed PAIS and instead the water would have to be piped in from existing sources. Fresh shallow groundwater (3-15 feet in the north, 3-10 feet in the south) existed in the dunes as a lens floating on saline water but was probably not more than a few feet deep. Electric logs in the bay did not locate any potable deep groundwater in the north and no logs were available for the south end of the island.

Boylan (1986) conducted a year-long study examining the effects of season, meteorology and tides on the groundwater at PAIS. Sharp et al. (1992) examined the hydrology of PAIS and attempted to characterize the chemistry of the groundwater and determine the configuration of the freshwater lens.

The University of Texas conducted two hydrogeologic surveys during 1997 and 2001 (Sharp 1997, 2001). They collected data on the groundwater levels and chemistry of the park, the shape of the freshwater lens and the extent of hydrocarbon contamination.

Berkebile (1995) conducted a recent investigation into the groundwater at PAIS. In his Phase I report he described the aquifer as having three distinct zones: the hypersaline, the freshwater and the seawater. As with Myers, Berkebile found that the freshwater recharge comes from precipitation on the island but also found that the aquifer was not directly connected to the mainland aquifer. Groundwater chemistry was described in the Phase II draft report (Berkebile & Hay 2001). Monitoring of wells occurred monthly, in the beginning, then at least quarterly. Berkebile and Hay found that the ammonia levels were very high in wells near the saline zone. It was thought that this was due to high N production from the algal mat on the wind tidal flats instead of an anthropogenic source. They also monitored three ponds in the northern portion of the park for changes in water levels. These were the most recent studies on groundwater at the park (D. L. Echols, personal communication, 12 March 2004).

Experts: John Sharp (University of Texas Austin), Todd Halihan (Oklahoma State University), Jennifer Prouty (Coastal Research Associates, Corpus Christi)

Surface water

General studies

Tunnell and Judd (2002) described the hydrology of the Laguna Madre. They also discussed multiple ecosystems in the estuary including seagrass meadows, open bay, wind-tidal flats and barrier islands, and the organisms that inhabit them. They also discuss the water chemistry.

Water quality

Area waters

Copeland et al. (1968) examined the correlation between water level, wind direction and velocity in Laguna Madre and found that wind strongly influenced the water levels in the area.

Bowman (1972) documented the domestic waste and possible pollution of Laguna Madre by 115 houses located on spoil islands. Three fourths of these houses were located within PAIS and were designated for removal from the seashore.

Warshaw (1975) examined the water quality of Laguna Madre and found that it was highly influenced by industry, shipping and fishing in particular. It was a highly unstable environment due to its elevated salinity, temperatures, existence of nutrients and heavy metals, and influence of weather, but remains a robust system.

Suttle and Chan (1995) documented 64 natural virus communities from water sampled along south coastal Texas. Sixteen samples contained a virus that affects *Chrysochromulina brevifilum* and were thought to be important in regulating populations and reducing the number of blooms.

Stordal (1996) and Stordal et al. (1996) examined the levels of arsenic, selenium, mercury and antimony of waters near Padre Island including Corpus Christi Bay and Laguna Madre. Water

samples had significantly higher (one to three orders of magnitude) mercury methylation rates than previously measured ‘specific rates.’ Stordal et al. (1996) examined the mercury content of surface water samples collected in multiple estuaries near PAIS.

Ward and Armstrong (1997) assessed the water, sediment, and tissue (fish and shellfish) quality of the CCBNEP, which includes the upper Laguna Madre, using a compilation of data from multiple surveys and research projects performed in the area. They discussed trends for each type of data and addressed the deficiencies in data collection and management. Quenzer et al. (1998) created a model of the total load and water quality for the CCBNEP using elevation, stream network and discharge, precipitation, water quality, and landuse data sets. Carr et al. (1998) examined the sediment associated with stormwater outfalls for potential contamination at 36 sites in the CCBNEP. They analyzed samples for microbial indicators, physical properties, concentration of contaminants, toxicity, and benthic community. Several of these variables, such as contaminant concentrations and fecal coliform, exceeded quality guideline levels at a number of sites. They determined that several sites were affected by human impacts.

Castro et al. (2003) examined the amount and source of total nitrogen (TN) in estuaries along the Eastern and Gulf coasts. The sources varied according to the watershed and the lowest TN was found in Laguna Madre. The authors recommended implementing reduction programs that target the dominant N source for the watershed.

Water quality data for surface water in the state, including the Corpus Christi area, have been monitored by Texas Commission on Environmental Quality (TCEQ) since 2000. Data and summaries of the physical, chemical, and biological parameters of these waterbodies are listed on their website (Texas Commission on Environmental Quality 2004b). To comply with Section 303(d) of the Clean Water Act, states are required to compile a list of impaired waters every two years. The 2000 Texas State list contained two waterbodies in PAIS (Table 1).

Table 1. Waterbodies within PAIS listed on the Texas state 2000 303(d) list, which denotes waterbodies that do not meet the standards set for their use.

Waterway	Overall rank	Concern	Summary
Gulf of Mexico	low	mercury in king mackerel, depressed dissolved oxygen	The fish consumption use is not supported, based on a non-consumption advisory issued for sensitive subpopulations by the Texas Department of Health in 1997 due to elevated concentrations of mercury in king mackerel greater than 43 inches long. Dissolved oxygen concentrations near Sabine Pass are occasionally lower than the criterion established to assure optimum conditions for aquatic life.
Laguna Madre	low	Depressed dissolved oxygen, bacteria	In the upper third of the Laguna Madre and in a localized area near the mouth of the Arroyo Colorado, dissolved oxygen concentrations are occasionally lower than the criterion established to provide optimum conditions for aquatic life. Based on Texas Department of Health shellfish maps, 5.2% of the bay (18.1 square miles near the Arroyo Colorado and along the Intracoastal Waterway) does not support the oyster water use due to potential contamination by human pathogens.

Padre Island inland waters

Keller (1972) conducted a high school class study on the variation between a freshwater and saltwater pond at PAIS. They examined the contour of the ponds, temperature and other water parameters.

Hannan et al. (1978) examined the effect of the septic system of the PAIS ranger station on the water quality and aquatic ecosystem of the nearby ephemeral and permanent ponds. They found that the enrichment of the ponds was due to the high avian populations surrounding the ponds but that no pollution occurred from man-made sources, although leach fields did exist around the septic tank.

In a primary productivity study, Serota (1971) examined seasonal variation in two permanent freshwater ponds at PAIS. Sissom et al. (1990) conducted a study to establish baseline data for the chemical and physical properties of the water of three freshwater ponds on PAIS. They collected and summarized data on the biotic community including amphibians, reptiles, mammals, birds, arthropods, fish, mollusks, plants, plankton and fungi as well as water quality parameters. In a follow-up study to Sissom et al., Jones and Dyson (2003) examined the water quality of the same three ponds. They documented any changes that had occurred on the ponds since the 1989 measurements, including increased P levels in two ponds, a color change of one pond and a decreased salinity of the most saline pond.

A baseline inventory of water quality of PAIS, which examined data from the Environmental Protection Agency's (EPA) databases, found 13 groups of parameters that exceeded water quality screening limits at least one time (between 1941 and 1998) in the study area (Horizon

Systems Corp. 2003). Seventy-three of the 257 monitoring stations were located within the park; the rest exist within the study area. This report described waters that have been historically impacted by anthropogenic activities such as development, marine traffic, oil and gas exploration and development, recreation, wastewater discharge, atmospheric deposition and dredge and spoil operations.

Salinity

The salinity of Laguna Madre is much higher than the salinity of most oceans (Gunter 1945). The hypersaline water sinks to the bottom of the basin and cannot flow out. This high salinity level has been linked to large fish kills in some years, but it was also believed that the increased salinity, if it was not too high, was favorable to fish yield.

Behrens (1966) examined the surface salinities of the upper Laguna Madre and Baffin Bay. He found that the salinity for Laguna Madre was normally between 30 and 50 ppt and as high as 75 ppt during a drought. Baffin Bay had a slightly decreased range of 40 to 50 ppt but could reach as high as 85 ppt in a drought period.

Experts: Kim Jones (Texas A&M Kingsville)

AIR QUALITY

There are only a few reports on the air quality at PAIS. Gibich et al. (1973) reported air quality levels for test sites on PAIS including ozone, nitrogen dioxide, sulfur dioxide, hydrocarbons and methane. An air emissions inventory was conducted during 2001 at the park to examine sources and levels of air pollutants (EA Engineering Science and Technology Inc. 2003). This report documented the sources and magnitude of in-park emissions, identified strategies to mitigate emissions, and evaluates compliance with state and federal air pollution regulations (D. L. Echols, personal communication, 16 September 2004). According to the State of Texas, PAIS was designated as a Class II air shed. Oil and gas operations in the park were the main source of possible air quality issues.

Two long-term collection programs have recently placed monitoring stations on the park and are currently collecting data on the local air quality. The first was conducted by the Texas Natural Resource Conservation Commission (TNRCC). They maintain a searchable database for historic and current air quality measurements (including 95 volatile organic compounds, such as benzene, toluene, ethylene, etc) for the state including stations in the Corpus Christi area and one on the park (Texas Commission on Environmental Quality 2004a). The park monitoring station is operated by TCEQ and annual data summary reports are available from the state. Data from these locations are contributing to a large study looking at the formation and transport of air pollutants along the gulf coast of Texas (T. Maniero, personal communication, May 2004). The NPS Air Resource Division is participating in a second long-term study with the EPA National Dioxin Air Monitoring Network (NDAMN). NDAMN monitors multiple sampling sites across

the United States to collect long-term, background atmospheric levels of dioxin-type compounds, especially those near agriculture.

In 1997, the state evaluated water, sediment cores, and fish tissues in 13 reservoirs and lakes in east Texas to study mercury accumulation. Kimball Reservoir, Hardin County, near Big Thicket National Preserve, had the highest fish tissue concentrations. Sediment cores suggested mercury concentrations had been increasing in west Texas over time. More information and data, can be found on the TNRCC website (T. Maniero, personal communication, May 2004).

The air quality of PAIS can also be assessed from National Atmospheric Deposition Program/National Trends Network (NADP/NTN) data collected from the Beeville, TX site (TX03, ~70 miles NW of PAIS) operational in 1984 and the Corpus Christi, TX site (#TX39, ~25 miles NW of PAIS) that began operations in January 2002. Trend data are not yet available for the latter site, but the Beeville site data show a slight decrease in wet sulfate and wet nitrate concentration, but no trend in wet ammonium concentration and deposition or in wet sulfate and wet nitrate deposition. Two NADP Mercury Deposition Network (MDN) sites are at Longview, TX (#TX21), operational since November 1995 and at Fort Worth (#TX50), operational since August 2001, both ~375 miles N of PAIS. There are no MDN monitors in central or southeast Texas, thus no meaningful mercury data exists (T. Maniero, personal communication, May 2004).

The nearest Clean Air Status and Trends Network (CASTNet) sites are at Big Bend NP, TX (#BBE401 ~385 miles NW of PAIS) operational since 1995 and at Caddo Valley, AR (#CAD150, ~560 miles NE of PAIS) operational since 1988, and the nearest Interagency Monitoring of Protected Visual Environments (IMPROVE) site is also at Big Bend NP, Texas (#BIBE) operational since 1988. These sites are all too distant to be meaningful for assessing acid deposition or visibility on PAIS. It has been suggested that installing an IMPROVE monitor at PAIS would improve regional coverage for the Texas parks and should be considered (T. Maniero, personal communication, May 2004).

Experts: Mike Sheen (TCEQ), Tonnie Maniero (NPS ARD), Mike George (NPA Air Resource Division), Steve Spaw (TNRCC)

ECOSYSTEM STUDIES

COASTAL DUNES AND BEACHES

General

Boker (1956) studied five types of sand dunes on Northern Padre Island. He examined dune development, migration, sedimentation and erosion, and conducted a granulometric analysis of the dune sands. He also discussed the geological history, sediment development and movement, actions of wind and tides, vegetation, creation of blowout dunes, shrub-coppice dunes, source of sand and sand composition, and roundness and surface texture. Price and Kornicker (1961) examined fragments of *Mulinia lateralis* shells found imbedded in the clay dunes south of PAIS near Port Isabel. They found that wind could transport these shells from Laguna Madre, where they live up the steep slopes, and deposit them concave side down on these dunes. Milling and Behrens (1966) examined the structural composition of beach and dune sediments on Mustang Island. Hill and Hunter (1976) described the biological and geological processes that affect the marine and shore environment at PAIS. Chaney et al. (1980) conducted transects on four beach areas to examine vegetation and sedimentation of the foredunes. Species composition and height of foredunes varied but no trends were found. Chaney and Williges (1981) conducted a study examining the foredune vegetation occurring on Nortraf, Pedtraf, Vehtraf and Shell Beaches.

Hummel (1982) conducted a study on the development, subsurface characteristics and deposits of interdunes in the back-island dune field on North Padre Island. He examined the effects of wind, moisture, and wet or dry weather on deposition, accretion, continuing migration and the amount of sediment deposited in the interdune. Hummel and Kocurek (1984) compared the interdunal areas at PAIS to ancient examples. They examined various attributes of the interdunal area including sand storage, deposition and accretion, size and thickness, moisture load, adhesion structures and penecontemporaneous deformation. Kocurek et al. (1991, 1992) examined the cycles of dunes and dune fields on PAIS. They examined the effects of the water table, wind, sand quantities, and transport and accretion of interdunal deposits on the evolution of the dunes.

Eolian dunes

Johnson (1955) studied the Eolian Plain of coastal South Texas and examined the eolian activity of PAIS. McBride and Hayes (1962) took advantage of the destruction caused by Hurricane Carla to examine exposed dune cross-beds on Mustang Island. Results from this study suggested that the eolian cross-beds were not necessarily thick. Hunter (1977) studied the basic types of stratification in eolian cross-stratified sands located in sand dune fields at multiple sites, including one at PAIS. The study focused on sands that were one meter or less above the dune base. Weiner (1982) examined the eolian stratification types found in the oblique dunes on South Padre Island. He found oblique dune movements were more influenced by long-term weather conditions than catastrophic weather events such as hurricanes. Sweet and Kocurek (1988) examined the driving factors that determine dune spacing in eolian dunes. They found that aerodynamic wake did not control spacing but it was important in the conservation of sand. Sweet (1989) discussed airflow dynamics of Eolian dunes and found that the nature of the lee-

face airflow was influenced by multiple factors including dune shape, stability of atmospheric temperatures, and the brinkline and wind direction incidence angle.

Effects of Recreational Use

Baccus et al. (1977) studied the effect recreational use had on the flora and fauna of beach and dunes on PAIS. They identified differences in vegetation between heavy and light usage and examined relationships between mammals and vegetation to determine indirect effects of the habitat damage. They also examined the relationship of beach and dune profiles to sand storage and monitored storms to determine the effect of storm surge and wave damage. In another paper Baccus and Horton (1979) further discussed the impact of recreational use of the beach and dunes as it relates to topography, sediment, flora, fauna, weather and fire. They found that shell beaches were affected by high foredunes, Gulf currents, Aeolian erosion, hurricanes, pedestrian and vehicular traffic, flora, fauna and fire. Historical disturbance to the island has included overgrazing and drought, which were compounded by high winds and tides of hurricanes. These problems were exacerbated by the large volume of visitors the park receives.

Mathewson (1974) described the resulting impact of human induced breaches in the main dune wall on South Beach Padre Island. These breaches lead to wide drainage channels causing beach washouts. He recommended rebuilding the dune wall and excluding portions of the area to human activity so natural dune formation may resume. Mathewson (1975) described the change in aerodynamics that directed most wind carried sand through the chutes in the vegetated dune wall. These chutes resulted from human forces or prior storm activity. Mathewson et al. (1975) studied the effects of short-term (e.g., storms and hurricanes) and long-term (e.g., wind and water transport, erosion) natural processes and human induced changes (e.g., development on PAIS). In a separate article, Mathewson (1977) discussed the effects the short-term processes have on the stability of the foredune ridges on PAIS. He found that a high level of erosion occurred to the gulf side of barrier islands due to Hurricane Carla (1961) and suggested that natural reconstruction, instead of creating an artificial dune with plantings, would stop future washouts.

McAtee and Drawe (1974) discussed the preliminary results of their study to examine the effects of high traffic, both vehicular and foot, on the beach and foredunes of PAIS. They examined a variety of components in the system including the number of visitors, vegetation cover and the environmental attributes of the soil, water and atmosphere. In his thesis, McAtee (1975) expanded this study and discussed the amount of vegetation in beach and foredunes of PAIS and ascertain an appropriate amount of usage that would balance recreation and stability of the environment. He also collected vegetation samples for an herbarium. McAtee and Drawe (1981) further discussed damage caused by vehicular and pedestrian traffic to the vegetation in beach and foredune areas on North Padre Island and PAIS. They found that weather, salinity, evaporation and conditions in the atmosphere also affected these habitats.

Blum and Jones (1985) examined and compared the density and complexity of foredune vegetation on five sites on North Padre Island. Their finding suggested that differences were due to the amount of traffic each site received.

Lonard et al. (1991) studied the effects of Park Road 100, which travels through South Padre Island, on coastal dunes. They found that the vehicular and camp traffic associated with this road destroyed vegetation and influenced wind and sand damage.

Dune Stabilization

Tauscher (1966) described a sand dune stabilization experiment on 14 test plots in a 6.6 acre control area. The study examined water salinity and the effects of vegetation, fertilizer, grazing and irrigation on sand stabilization.

Otteni et al. (1971) conducted a four-year study to examine the use of grasses to stabilize dunes at PAIS. They found that establishment rates were higher when transplanting small individual clumps of species such as bitter panicum (top choice) or sea oats. High soil moisture and reduced salinity were more important than soil and air temperature for planting. They did not find any differences in nutrient levels between the foredune, interdune and hinddune.

Dahl et al. (1974) conducted a five-year study (1969 to 1973) that examined foredune stabilization with native grasses. Although a barrier island provides protection for mainland coastal zones, if foredunes erode due to human or natural influences, such as grazing, hurricanes, drought, or burning, protection for the coast declines. The study found that native grasses, bitter panicum in particular, were the best vegetation to stabilize foredunes. After Hurricane Allen, Dahl (n.d.) was able to use baseline data from the previous study to compare the effects of the hurricane on experimental dunes and control sites. Post Allen, dunes were monitored from 1975 to 1977 and 1981. They found foredunes with good vegetation prevented sand from moving inland. This allowed back beaches, which were denuded by the hurricane, to revegetate to a grassland.

Sand distribution

Hayes (1963) analyzed 60 dune and 16 beach samples for grain size on Padre Island. He found no difference between the two types but did find differences between the sand found on the northern and southern end of the island. Sand along the southern end was coarse and deposited by the Rio Grande. The finer sand in the north was deposited by the Nueces, Colorado and several other rivers to the north. A transition zone exists in the middle of the island where the sand is an equal measure of the two sizes.

Dickinson and Hunter (1970) discussed how the variation in grain size on beaches of Padre Island could be explained by the way in which they were deposited. They also found that Padre Island was not a prograding island because the sand size does not decrease with increased depth.

Davis (1978) monitored multiple beaches on Mustang and Padre Islands to determine the influence of season and geographic area on sedimentation. He found that there were three distinct geographic areas. Grain size did not vary much due to season in the southern and northern provinces, but they did in the convergence area.

Mazzullo et al. (1983) conducted a study to determine the source of the sand of North Padre Island. They examined sand from the Brazo-Colorado Rivers and the Rio Grande and found the gross grain shape of the island was only abundant in the Rio Grande. Mazzullo and Sims (1983) also examined gross and fine shape characteristics, using the Fourier shape technique, to differentiate beach and dune sands from Malaquite beach, Padre Island.

Russell (1987) examined Big Shell and Little Shell Beaches of PAIS. These were examples of exogenous processes deposited by the sea. They discussed the geological features, vegetation and animals of the beaches. They found differences in the distribution of sand grain size and mineralogies between the two beaches.

PONDS, WETLANDS

Keller (1972) conducted a high school class study on the variation between freshwater and saltwater ponds at PAIS. They examined the contour of the pond, temperature and other water parameters, and recorded bird and vegetation species in the habitat.

Landsat imagery was tested on South Padre Island to delineate wetlands and landuse (Finley 1976). Lonard et al. (n.d.) conducted a study to examine the species composition of vegetation found in the non-tidal wetland communities on South Padre Island.

Hannan et al. (1978) examined the effect of the septic system of the PAIS ranger station on the water quality and aquatic ecosystem of the nearby ephemeral and permanent ponds. They found that the ponds were not contaminated by the septic system but water levels were too low to compare the flora and fauna of the ponds.

Serota (1971) conducted a study to examine the relationship between primary productivity and the standing crop of chlorophyll as well as seasonal variations in two permanent freshwater ponds at PAIS. He also assessed any effects hydrology and climate had on the relationship.

Sissom et al. (1990) conducted a study to establish baseline data for the chemical and physical properties of the water and the flora and fauna living within the pond and on the shores of three freshwater ponds on PAIS. They collected and summarized data on the biotic community including amphibians, reptiles, mammals, birds, arthropods, fish, mollusks, plants, plankton and fungi as well as water quality parameters.

Oxley (1992) surveyed three brackish ponds on PAIS to determine which fungi inhabit the ponds. She collected samples, looked for fungal relationships in the ponds and examined whether 'true' marine species inhabit the ponds that were not entirely marine.

Caudle (1992) studied the population dynamics of mosquitofish, sheepshead minnow, and Gulf killifish, in three earthen ponds on north PAIS. He examined abundance, recruitment, size class progression and tolerance to salinity.

SPOIL ISLANDS

Most studies that have been conducted on the spoil islands have focused on the avian species that inhabit the islands. Cahn (1922) described the general natural history of Bird Island when he conducted the first bird survey for the island. The island has minimal low-lying vegetation with no shade and few inhabitants other than the extensive breeding bird populations. McMurray (1971) conducted a study examining Reddish Egret nesting behavior and success on a spoil island in Laguna Madre. Simersky (1972, 1971) compared the nest success and site selection of four heron species, Snowy Egret, Reddish Egret, Louisiana Heron and Great Blue Heron, on four spoil islands in Laguna Madre. She found that the presence of people and the addition of spoil to the islands during the incubation and early nestling stages negatively affected their nesting success. Great Blue Herons had the only stable population between years likely due to their resident status. Mendoza and Ortiz (1974) examined the vegetation, bird populations and soils of 11 spoil bank islands in the upper Laguna Madre. They conducted soil analysis and created checklists for the plants and birds found on the sampling sites. Depue (1974) conducted a study on the breeding ecology of the Black Skimmer on spoil islands of PAIS during 1972 and 1973. He documented the reproductive activity at the nest, site selection, general biological parameters of the nest, eggs and young, and provided management recommendations and ideas for future studies. During this study, Depue also examined the use of these islands by other species of birds. Mrazek (1974) studied the effect that fire ant colonies had on bird nests on two spoil islands in Laguna Madre. He described the ecology of the ant population and its effect on 8 bird species nesting on the island. Chaney et al. (1978) conducted a study on spoil islands in Laguna Madre to examine soils, vegetation and animal populations, use by seabirds and wading birds and compared avian nesting sites with 'natural' sites on the coast.

A couple of studies have focused on other aspects of the spoil islands. Barnes (1971) examined a spoil island adjacent to PAIS in Laguna Madre and described the topography, occurrence of ponds, vegetation and soils of the site. Bowman (1972) documented the domestic waste and possible pollution of Laguna Madre by 115 houses located on spoil islands. Three fourths of these houses were located within PAIS and were designated for removal from the seashore. Stinson and Clary (1974) studied the effect of wind and waves on the morphology of a spoil island in Laguna Madre. In a follow-up to Chaney et al. (1978), Sims et al. (2002) documented the current vegetation and physical characteristics of the islands and compared them with historic conditions. Recommendations were given for the management of these islands. Smith and Sims (2002) conducted a study of eight spoil islands to examine annual changes in vegetation, but did not find changes in the overall structure of the vegetation during the year.

THE GULF - REEF SYSTEM

A number of studies have examined the biotic communities of Seven and One-half Fathom Reef. Causey (1969) examined the fish populations associated with the reef and identified 87 fish species, their densities, distributions and their dependence on hydrology. Thirteen of these species were previously not designated in the Northwestern Gulf. Felder (1971) studied the species present, density, distribution and seasonal variation of decapod crustaceans. Tunnel (1969, 1973) conducted a survey of Mollusca and found 169 species on the reef. McCarty

(1974) conducted a study on polychaetes found on the reef and created a list of 88 documented species. Shirley (1974) examined the echinoderm species found on the reef and documented 26 species of echinoderms, including 8 new species. Diet analysis of 31 species of predator fish from the area found that the fish fed heaviest on the most abundant echinoderm species.

ESTUARIES

General Laguna Madre

Fisk (1959) described the formation of Laguna Madre and the Flats, which divide the lagoon into what is known as upper and lower Laguna Madre. Physical descriptions of depths and elevations were given as well as sources of sedimentation and the resulting effects on the properties of the water and the lagoon's biotic community.

Breuer (1962) conducted an ecological survey of the lower Laguna Madre, examining the hydrology and ecology of the species present. He found that salinity increased during the summer months as the water moved north from the Gulf and evaporation increased. The water flow reversed in the winter. The report included information on salinities, wind, rainfall, tidal effects and species present.

Physical properties

Smith and Evans (1976) conducted a two-year study of Laguna Madre to record physical processes that occur in the estuary. They measured water circulation, residence time and how these affected water quality in the upper Laguna Madre. Additionally, they used temperature and salinity to determine how water traveled as well as how the quantity and location of spoil islands effected circulation, tides and weather formations.

Smith (1977) examined the daily temperature variation that occurred during winter in a shallow seagrass flat in Laguna Madre. He found that the diurnal temperature ranged around 2.4 degrees Celsius. Warming began around 0800 for 8 hours, followed by a slow cooling phase for the rest of the 24-hour period. Smith (1978) conducted a study to examine water level variations in the upper Laguna Madre and found that significant differences occurred due to the thermohaline and dynamic processes in the Gulf of Mexico, as well as weather induced changes in the coastal sea level. Water movements and damping of tidal motions were traced from the coast.

The Texas Department of Water Resources (1983) examined the effect of supplemental water added to the annual inflow of freshwater into Laguna Madre.

Ward and Armstrong (1997) assessed the water, sediment, and tissue (fish and shellfish) quality of the CCBNEP, which includes the upper Laguna Madre, using a compilation of data from multiple surveys and research projects performed in the area. They discussed trends for each type of data and addressed the deficiencies in data collection and management. Quenzer et al. (1998) created a model of the total load and water quality for the CCBNEP using elevation, stream network and discharge, precipitation, water quality, and landuse data sets. Carr et al.

(1998) examined the sediment associated with stormwater outfalls for potential contamination at 36 sites in the CCBNEP. They analyzed samples for microbial indicators, physical properties, concentration of contaminants, toxicity, and benthic community. Several of these variables, such as contaminant concentrations and fecal coliform, exceeded quality guideline levels at a number of sites. They determined that several sites were affected by human impacts.

Ziegler and Benner (1998) found similar gross primary productivity and respiration rates when studying the ecosystem metabolism in Laguna Madre. They found evidence that the heterotrophic activity in the water column was fueled by benthos.

Sharma et al. (1999) examined the possible metal contamination of 22 sites in the upper Laguna Madre.

Morse (1999) examined sedimentary iron sulfide formation in the iron limiting sands of Laguna Madre. Morin and Morse (1999) examined the role of sediments in buffering waters from ammonium.

Morton et al. (2000) compared the rate of sedimentation and submergence in Laguna Madre and found that it was slowly submerging and migrating to the west due to the high rate of subsidence and erosion of the western shore.

An et al. (2001) developed and employed a method for estimating denitrification and N fixation of the sediments of Laguna Madre. Nitrogen fixation rates in this system were higher than denitrification rates. An and Gardner (2002) examined the fates of N in Laguna Madre and found that the inhibited denitrification may preserve N in this system with limited water exchange.

Buzas-Stephens (2001) and Buzas-Stephens et al. (2003) examined the sediment cores of four sites along the South Texas Coast including the Laguna Madre, Nueces Bay, Arroyo Colorado and Laguna Atascosa, to evaluate the effect of pollution on foraminifera populations. Although geochemical analysis of the samples indicated low pollution, the foraminiferal assemblages were abnormal in Arroyo Colorado.

Teeter (2002) examined the transport of sediment in Laguna Madre. Areas with no vegetation had higher levels of suspended sediment than vegetated areas, some by an order of magnitude. Measurements taken near dredge-pipeline discharge detected high sediment levels in the underflow hundreds of meters from the area of deposition.

Fossils and assemblages

Parker (1959) examined the distribution of macroinvertebrate assemblages in coastal bays and Laguna Madre to develop criteria for interpreting the depositional environments of current and historic sediment. Five assemblages were documented in Laguna Madre. Colburn (1996) examined the effect of environmental conditions in Laguna Madre on the morphology of *Ammonia beccarii*. Salinity appeared to have the greatest effect on morphology.

Based on Coquina fossils and other geologic features found along the mainland shore of Laguna Madre, Prouty and Lovejoy (1992) proposed that South Texas climate may have historically been wetter and hotter than it is currently.

Pitakpaivan (1988) examined sediments of Baffin Bay and found a low diversity in the foraminiferal and ostracodes assemblages. Seventeen species of foraminiferal were found in the samples but one species, *Ammonia parkinsoniana*, made up 75% of the population. Sixty percent of the ostracodes assemblages were represented by four species. He proposes that the fluctuations in salinity create an unstable high stress environment and result in the low diversity. Montagna (1992) compiled a species list from benthic samples collected in Laguna Madre during 1989-1992.

Biota

Johnson (1963) conducted a study on the juvenile shrimp populations found in the lower Laguna Madre. Stokes (1974) described the results of a study that examined brown, white and pink shrimp populations in the lower Laguna Madre, including their abundance and the effect of ecological factors on the populations. Smith (1985) examined the macroinvertebrate populations in the lower Laguna Madre.

Conover (1963) examined benthic communities in Laguna Madre and other saline lagoons on the Texas Gulf Coast. He detailed seasonal growth patterns, reproductive cycles, community distributions and seasonal variations of environmental factors. Montagna et al. (1998) examined the effects of disturbance on the benthic habitat of the CCBNEP. They found that both natural and anthropogenic disturbances have an effect on the benthic community but that the effect of both types is greater than the sum of each individual disturbance. Sheridan (1999) examined the effects of the placement of dredged materials on the vegetation and benthic invertebrate communities in Laguna Madre. He found that the establishment of vegetation on shallow dredged material deposits occurred within 5 years but invertebrate communities took longer (5-10 years). The areas bordering the GIWW were continually disrupted due to the addition of dredged material. Recommendations for placement of dredge material that would protect seagrass beds were given.

West (1969) performed a study on the carrying capacity for waterfowl in the upper Laguna Madre and other local waterways. He developed vegetation maps, created permanent vegetation transects and conducted an inventory of aquatic flora and fauna that were important for waterfowl subsistence. Bowles (1980) surveyed winter populations of Red-breasted Mergansers in Laguna Madre. He studied their foraging behavior, migration, sex and age ratios, body conditions, time budgets, chronology of pair formation and lead poisoning. Ballard (2001) conducted a study on the diets and nutritional fitness of Northern Pintails wintering in Laguna Madre. Saltwater habitats provided lower quality food in terms of energy than freshwater habitats and may have resulted in pintails leaving wintering grounds in a disadvantaged state, although data from the Texas Coast did not support this reasoning.

Traylor et al. (1981) compared biotic samples from five aquatic habitats, including Laguna Madre. They found that the biota varied for each site and was related to the substrate, nutrient and light availability, water temperature and salinity, slope, aspect and wave action.

Hensley (1986) examined the reproduction of longnose killifish populations found in the lower Laguna Madre. Lacson and Lee (1997) conducted a study on the relative abundance of six finfish (red drum, spotted seatrout, black drum, Atlantic croaker, Southern flounder, and Gulf menhaden) and four macroinvertebrates (white, brown, and pink shrimp, and blue crab) in the CCBNEP study area, which includes the upper Laguna Madre. They estimated relative abundance using data from otter trawl samples from 1982-1993 and bag seine and gill net samples from 1976-1993. They also created maps that depicted the relative abundance spatial throughout the study area.

Martinez-Bucciantini (1995) examined pure and cross-bred progeny of two distinct oyster populations from Offatt's Bayou and lower Laguna Madre. Survival was highest in pure crosses and there was a correlation between larval size and metamorphic success with survival rates higher in Laguna Madre.

Brown tide

DeYoe and Suttle (1994) investigated the role of N in a monospecific phytoplankton bloom, the brown tide (*Aureoumbra lagunensis*), which began in January 1990. They suggested that the bloom was triggered by a large fish kill.

Buskey and Hyatt (1995) discussed possible reasons for the resilience of the brown tide. A reduction in grazing due to the low nutrient content of the phytoplankton or its toxicity may have allowed for the persistence of this bloom. In further analysis, Buskey et al. (1997) found that the grazer population, benthic biomass and species diversity were very low prior to the bloom. Extreme drought and the resulting hypersalinity, coupled with a large nutrient flush from a fish kill, was thought to have allowed the phytoplankton to become established in this stressed system. Because the growth rate of this phytoplankton is greater than its grazers in hypersaline conditions, the low turnover rate and hypersalinity of the water may have allowed the brown tide to remain (Buskey et al. 1998). In another study, Buskey et al. (1999) found evidence that during the brown tide, C from seagrasses can be an important part of nutrition for copepods. Liu and Buskey (2000b) also found that a thick mucus layer was produced by the brown tide algae during hypersaline periods that may allow it to exist in higher saline concentrations than other algae. This mucus layer may also prevent predation due to a foul taste or disruption of zooplankton feeding apparatus (Liu & Buskey 2000a). Liu et al. (2001) also found that the algae had a high N:P critical ratio and an ability to use other forms of P that could allow it to exist in the phosphate-limited Laguna Madre.

Pulich et al. (1997) discussed seagrass trends and current status in the CCBNEP and correlated possible causes for these distribution trends. They found that the upper Laguna Madre and Baffin Bay hold 28.5% of the seagrass within TX. They found no turtle grass within the upper Laguna Madre, instead it was predominately shoalgrass. Research had found that the persistent

brown tide was having a serious negative effect on the seagrasses within the lagoon. From 1988 to 1996 3.8% of the total seagrass acreage was lost.

Street et al. (1997) conducted a study to examine whether the brown tide entered the estuarine food web. Stable isotope ratios indicated the brown tide was eaten by both the benthic and seagrass fauna although at differing percentages. Bersano (2000) examined possible reasons for the continued persistence of the Texas brown tide alga in Laguna Madre. Undigested cells of *A. lagunensis* were found in the herbivore *Acaria tonsa*. This resistance to digestion could help explain the ability of *A. lagunensis* populations to remain high.

Sharma et al. (2000b) investigated how dissolved metals affected the occurrence of the brown tide.

Buskey et al. (2001) examined brown tide levels after above-normal rainfall in 1997, which reduced salinities in Laguna Madre, and 1998 when the hypersalinity returned. They found that the brown tide recovered rapidly. Buskey et al. (2003) conducted a mesocosm experiment to test their hypothesis on how the brown tide persisted.

General seagrass beds

Merkord (1978) examined the distribution and abundance of the five predominant seagrass species in Laguna Madre, which is one of only two hypersaline lagoons in North America. Onuf (1996a) described the spatial and biomass variation that occurred in the four seagrass species across Laguna Madre. Strenth (2001) described common caulerpa (*Caulerpa prolifera*) populations in Laguna Madre. DeYoe and Hockaday (2001) examined the range expansion of two seaweeds (*Codium taylorii* and *C. prolifera*) into Laguna Madre.

Physical properties

Judd and Sides (1983) examined the effects of Hurricane Allen on near-shore vegetation on South Padre Island and found that due to the ease by which low-growing, shallow-rooted species were dislodged or covered with sand, they were more affected by strong storms than grasses.

Cninleo and Benner (1991) examined the role of bacterioplankton in the flow of C and energy in the Laguna Madre. Bacterioplankton is a large potential biomass source for higher trophic levels and may be a component between the seagrass and secondary producers in this system. Ziegler (1998) examined the environmental influences on C and N cycling in Laguna Madre. Carbon levels in the water table were found to be more influenced by seagrass exudation than previously thought. Dissolved organic matter also affects bacterioplankton production. Ziegler and Benner (1999) examined the importance of dissolved organic matter in a turtle grass meadow. Results indicated a strong link between the processes in the benthic layer and water column. Ziegler and Benner (2000) examined how production of bacterioplankton was affected by sunlight in Laguna Madre. Ultraviolet radiation did not negatively affect bacterioplankton (as well as phytoplankton) and photochemical processes were not a major factor in dissolved organic matter cycles. Jones et al. (2003) compared the level of stable C isotope ratios between three habitats

that varied in the amount of vegetation in Laguna Madre and found evidence for coupling between the abundant seagrass and bacteria in this system.

Using past vegetation maps of the lower Laguna Madre, Quammen and Onuf (1993) documented a decrease in acreage of shoalgrass and an increase in other seagrass species and bare bottom. Conversion to other species was correlated with a change in salinity and dredging was the suspected cause of the loss of seagrass.

Eldridge and Morse (2000) modeled the seagrass-sediment relationship in the Laguna Madre. They found an interaction between seagrasses and sedimentary diagenetic processes that lowered the sulfide concentration in the sediment to non-toxic levels for the seagrasses.

Kaldy et al. (2002) examined the contribution of seagrass to the net primary production in the lower Laguna Madre. Seagrass may be more important for structural habitat than C in the water column.

Biota

Williamson (1980) examined mollusk populations inhabiting seagrass beds in upper Laguna Madre to determine the effects of seasonal changes. Bivalve and gastropod populations were affected by changes in temperature and salinity.

Chaney (1988) sampled nekton and plankton in shoalgrass beds found in the upper Laguna Madre. Tolan et al. (1997) examined the importance of various seagrass meadows in the lower Laguna Madre for spawning grounds. Although larval stages showed no preference, juvenile-stage individuals preferentially chose the shallower shoalgrass habitat. Fifty-five species from 24 families were documented during surveys. Sheridan and Minello (2003) examined the effects of different sea grass species and disturbed vs. undisturbed sites on the fish and decapod populations. Results indicated that the characteristics of the seagrass were more important than the water column and sediment in determining densities of nektons.

McMahan (1967) conducted a study to examine the diets and distribution of two ducks, Redhead and Northern Pintail, which winter in Laguna Madre. Salinity tolerance of shoalgrass and manatee grass was examined to determine waterfowl sustainability in PAIS (McMahan 1968). McMahan found shoalgrass could exist in a wider range of salinity levels (9.0 to 52.5 ppt) than manatee grass, which did best at 35.0 ppt but died at 52.5 ppt. Shoalgrass was found to be an important food source for waterfowl, shrimp and fish, and manatee grass was not. He also discussed possible effects of the construction of fish passes and river diversion projects, which may affect water salinity and increase salt intolerant species such as manatee grass. McMahan (1970) reported on the diets of Redheads and pintails plus the Lesser Scaup, which also winters in Laguna Madre. Stomach contents revealed that the Lesser Scaup eats mainly mollusks but redheads and pintails feed mainly on shoalgrass. Cornelius (1977) studied wintering Redheads and food abundance on the lower Laguna Madre. He examined vegetation composition, shoalgrass yield, mollusk populations, exploitation of the available shoalgrass in the lower Laguna Madre and the distribution of Redheads along the central and lower Texas Coast. Marsh (1979) examined the nutrition of the Redhead population in Laguna Madre and possible effects

on their distribution, feeding habits and lead levels. Esophageal contents were almost entirely composed of shoalgrass. Nutritional analysis documented that manatee grass was inferior to the other marine plants analyzed. Mitchell (1991) and Mitchell et al. (1992, 1994) studied habitat use by Redheads on the lower Laguna Madre and examined the effects the species had on shoalgrass populations. Redheads favored lower salinity areas where they consumed more than three-quarters of the shoalgrass rhizome biomass each year and kept it below its maximum biomass.

Turtle grass beds

Kaldy (1997) examined the growth and ecology of turtle grass in Laguna Madre. Changes in energy allocation in different seasons and ages were studied as well as techniques for aging plant shoots.

Lee (1998) conducted a study to examine the N budget for turtle grass between two distinct populations in Corpus Christi and Laguna Madre. High sediment N caused increased leaf growth and plants in low level conditions increased belowground growth. Experiments suggest that the Laguna Madre population was limited by availability of sediment N. Herzka and Dunton (1998) conducted a study of turtle grass in the lower Laguna Madre to examine the influence of light and C in current production models. Lee and Dunton (1999a&b) investigated how changes in N availability in sediments affected the C and N content of turtle grass in Laguna Madre. Increased N levels produced high leaf growth and low levels encouraged high belowground growth.

Kaldy and Dunton (1999) examined possible explanations for the rapid northern expansion of turtle grass in Laguna Madre. Ecological features such as high seed production, high survival rate and floating seed as well as changes in carbon cycling were important in the dispersal and colonization of the species.

Kaldy et al. (1999) examined turtle grass shoots in Laguna Madre to assess the accuracy of determining shoot age. They found the growth was influenced by site, season and yearly variation, which affect the accuracy of the method. Kaldy and Dunton (2000) investigated whole plant growth and reproduction in turtle grass and found seasonal variation of environmental factors, such as day length, temperature and irradiance, were the most important factors in determining growth. Lee and Dunton (2000b) studied turtle grass in Corpus Christi Bay and lower Laguna Madre to examine how sediment ammonium affected seagrass growth and allocation. Seagrass productivity in Laguna Madre was limited by N availability.

Lee and Dunton (2000a) investigated the interaction between turtle grass and sulfide in Corpus Christi Bay and Laguna Madre. Seagrasses modified the chemical environment of the sediments and created a beneficial environment for seagrass production.

Major and Dunton (2002) tested the extent to which turtle grass can compensate for light variation. Turtle grass could adjust both in structure and function to adapt to changes in light availability.

Shoalgrass beds

Circe (1979) examined shoalgrass in four zones, pioneer, complete, transition and original, around spoil islands. He found that the zones differed in water depth, vegetative biomass, microinfauna, sediment grain size and C content.

Opsahl and Benner (1993) studied the decomposition of senescent blades of shoalgrass in the water column of Laguna Madre and documented a large initial organic matter loss due to leaching and found photobleaching was important in degrading plant tissues.

Dunton (1994a) studied the effect of light availability on seasonal growth and biomass of shoalgrass along the south Texas Coast. Populations in Laguna Madre experienced decreases in growth and biomass due to low light conditions caused by the brown tide. Dunton and Tomasko (1994) examined the photosynthesis versus irradiance of shoalgrass from Laguna Madre. Onuf (1996b) examined the effect of light reduction caused by brown tide on shoalgrass distribution. No response was detected in the first two years but losses were seen by the winter of 1993. Burd and Dunton (2001) examined the importance of light in the above and below ground growth of shoalgrass and successfully modeled the changes in biomass using data from Laguna Madre.

Tomasko and Dunton (1995) examined four techniques to estimate daily C budgets for shoalgrass in Laguna Madre and found that they varied in accuracy and recommended using whole-plant estimates for obtaining realistic estimates.

Dunton (1996) studied seasonal changes in photosynthetic production and whole plant biomass of shoalgrass along the Gulf of Mexico with respect to an estuarine gradient. Shoalgrass grew equally well in a range of salinities, nutrient levels and light availability. Kowalski (1999) examined production of shoalgrass in lower Laguna Madre. The species showed a lower growth rate and biomass than other Texas estuaries and was likely nutrient limited, which may explain the current displacement by turtle grass.

Hicks et al. (1998) monitored changes resulting from abnormally cold temperatures on shoalgrass. Freezing did not affect the above or belowground biomass.

Major and Dunton (2000) examined photosynthesis in manateeegrass and found it may have the ability to modify its photosynthetic apparatus structure in response to light availability.

Custer and Mitchell (1993) examined shoalgrass beds and biota for the presence of trace elements and organochlorine compounds associated with agriculture, which existed in elevated levels near agricultural sources. Levels varied for the trace elements and chemicals. Mercury was highest near agricultural areas in both sediment and blue crab populations, as was DDE. Arsenic levels were lowest in blue crabs, shoalgrass and brown shrimp near agriculture.

Tidal flats

Physical properties

Price (1968) conducted a study to examine ways to reduce or stop the salt and sand from blowing inland from the Central Flats region of Laguna Madre. Amdurer and Land (1982) examined the possible reasons that gypsum did not occur in the sediments of Sand Bulge of the Laguna Madre Flats. Tolbert (1985) investigated the sources, sinks and pathways of several trace metals in the near surface sediments of the Laguna Madre flats.

Long and Gudramovics (1983) examined the geochemistry of the brines in the wind tidal flat area in Laguna Madre. They found that the marine water was recharged during high winds when Laguna Madre waters were moved across the surface and continental waters were recharged through ground-water movement toward the coast. The brine was a sodium chloride solution with a continental and marine origin that chemically changes during evaporation by the precipitation of calcium carbonate and calcium sulfate minerals.

Biota

Chaney conducted two studies on the bird use of mud flats along the Laguna Madre on PAIS during the 1990's (Chaney et al. 1995b; Ecoservices 1993). Each study covered a different portion of the park but found a similar number of species and recorded thousands of birds on each survey day.

Withers (1994) examined the relationship between shorebird and macroinvertebrate abundance and distribution in the Laguna Madre adjacent to PAIS. Shorebirds were shown to have a significant effect on macrobenthos abundance. Presence or absence of the 22 shorebird species was not useful in predicting critical habitats. Over 50 species of macrobenthos were documented. Higher densities were found in soil depths less than 5 cm but biomass was often higher in 5-10 cm depths. Withers (1996) examined the recovery of benthic invertebrate populations in restored oil and gas impacted areas and vehicle tracks on PAIS. Sites varied in invertebrate densities but were both considered successful. Tire tracks, although initially damaging to populations, appeared to provide a beneficial habitat due to the longer period in which they maintained water. Withers (1998) examined the biological productivity of three southerly wind-tidal flats on PAIS. For each flat, core samples were collected to examine primary and secondary productivity, and bird surveys were conducted to examine consumer productivity. Sites varied in productivity with one site apparently an untapped resource for shorebirds. Withers also gave management recommendations for the mudflats. Withers and Tunnell (1998) summarized available information on the ecology, geology, and hydrology of the wind-flats found in the CCBNEP area, 79% of which are on the bay sides of San Jose, Mustang and Padre islands. They found that blue-green algae were the major primary producer and invertebrates provided the link between algae and the higher consumers such as birds and fish. The flats in the study area were one of the most important feeding areas along the Texas Gulf Coast for aquatic birds. The locations of human-induced and natural disturbances within the study area were also detailed.

Pulich and Scalan (1987) examined the pathway of C and N flow from marine cyanobacteria to insect food webs in the wind-tidal flat in the Laguna Madre.

Negrete (2000) examined a tidal flat community along Laguna Madre bordering PAIS and found it was dominated by *M. littoralis* and other salt tolerant plants.

MANAGEMENT ISSUES

The reports and studies in this section deal with management concerns at PAIS. Many of the park's management issues concern the protection of natural resources and mitigating the effects of various types of disturbance such as human use, cattle grazing, fire and storm impacts. Human use has caused both direct (destruction of habitat from pedestrians and vehicles, dredging and development) and indirect (e.g., contamination from trash, oil spills, and pesticide use) management concerns for the park. A detailed list of management issues and concerns that face PAIS and how these issues may affect the park's resources can be found in Appendix B.

ADJACENT LANDUSE IMPACTS

Singleton and Kiel (1957) conducted a study to examine effects of the construction of the Padre Island Causeway on the ducks and aquatic plants in the upper Laguna Madre and Corpus Christi Bay. Using surveys, maps and salinity records they determined that the Causeway had little effect on these populations except to increase silting in the area.

McMahan and Fritz (1967) conducted a survey to determine the extent to which trotlines injured ducks in the lower Laguna Madre. Laguna Madre is an important wintering ground for Redhead and Northern Pintails but it is also heavily used by commercial and recreational fisherman. Trotlines have become a dominant form of fishing in the area because netting became illegal. McMahan and Fritz estimated that over 20 thousand Redheads were killed during the three-month period the birds were in the area.

Price (1971) discussed the possible impact the Padre Isles development would have on PAIS. The proposed area for development was in a region that affects the terrestrial and marine ecology of the whole Laguna Madre system. Parker et al. (1974) conducted a three-year study on the effects of Padre Isles construction on PAIS. They examined water and biological quality, vegetative cover and the effect of the development on the local site as well as surrounding areas.

The over-development of Corpus Christi and its long-term impacts on the natural resources in the area are also concern (Author unknown 1973).

Mathewson (1974) described the resulting impact of human-induced breaches in the main dune wall on South Beach Padre Island. These breaches lead to wide drainage channels causing beach washouts. He recommended rebuilding the dune wall and excluding portions of the area to human activity so natural dune formation may resume. Mathewson (1975) described the change in aerodynamics that directed most wind-carried sand through the chutes in the vegetated dune wall. These chutes resulted from human forces or prior storm activity. Mathewson et al. (1975) studied the effects of short-term (e.g., storms and hurricanes) and long-term (e.g., wind and water transport, and erosion) natural processes and human-induced changes (e.g., development) on PAIS.

Ortiz (1976) conducted a study on the effect of human activity on the insects on Padre Island.

Rickner (1979) examined the effects of dredging on macrobenthos and seagrass populations. Onuf (1994) discussed the effects of dredging and light on seagrass populations in Laguna Madre. Sheridan (1999) examined the effects of the placement of dredged materials on the vegetation and benthic invertebrate communities in Laguna Madre. He found that the establishment of vegetation on shallow dredged material deposits occurred within 5 years but invertebrate communities took longer (5-10 years). The areas bordering the GIWW were continually disrupted due to the addition of dredged material. Recommendations for placement of dredge material that would protect seagrass beds were given. Sheridan and Minello (2003) examined the effects of different sea grass species and old dredge sites versus undisturbed sites on the fish and decapod populations. Results indicated that the characteristics of the seagrass were more important than water column and sediment in determining densities of nektons.

Kimber et al. (1984a&b) examined the effects of agriculture, fishing, recreation and urban development (industry, oil and gas infrastructure, commerce and settlement) on the barrier islands of Texas.

Withers and Tunnell (1998) discussed human-induced and natural disturbances within the wind-flats of CCBNEP study area. These areas are often chosen for sites for development or as sites for deposition of dredge spoils because they are considered barren wastelands by the public.

Williams (1999) used aerial photographs from 1938 to 1995 to examine the shoreline changes of Shamrock Island caused by the creation of a navigational channel in the 1950's and discussed how anthropogenic changes can cause unforeseen changes in the natural environment.

CONTAMINATION

Oil

In the waters off of PAIS, Jeffrey et al. (1977) examined the effect of seeding oil spills with bacteria on the rate of oil degradation and toxicity levels. Sturtevant (1979) examined the condition and amount of submerged oil from the IXTOC I spill on the coastal beaches. The largest amounts of oil exist in stable oil mats found in the intertidal and surf zones, with much of it buried in the moving sands. King (1979b) discussed preventative measures for Laguna Madre, Corpus Christi and Aransas Pass to avoid contamination of Brown Pelicans and their habitat by oil spills. In two additional reports, King (1979a&c) outlined preventive measures to protect Peregrine Falcons and Whooping Cranes, as well as their habitat from similar petroleum hydrocarbon spills. Scalan and Winters (1980) examined petroleum-like material found on PAIS to determine its source and quantity. The direct source was unknown due to the number of oil tankers in Corpus Christi Bay and seeps from the floor of the Gulf of Mexico.

Sadd et al. (1980) examined 28 washover events that have occurred on the barrier islands of South Texas, including North Padre Island and Mustang Island. Initiated by the IXTOX I oil spill and Tropical Storm Caroline, the report recommends procedures to reduce possible damage from future anthropogenic and natural sequences. Amos (1980) described sampling and observations of the oil distribution, both surface and subsurface, from the IXTOC I oil spill. A

study was conducted on the effects of this spill on the estuaries along the ends of PAIS (Benton & Snell 1980). Three tropical storms shifted the path of the spill and reduced the amount of oil to hit the beaches and estuaries. Changes in estuarine wetlands were documented using color infrared aerial photographs. Kindinger (1981) examined the effects of the IXTOC I oil spill on marine ecology on the Texas Coast, considering multiple variables including climatic factors, seasonal fluctuations and oil spill. Rabalais and Flint (1983) studied the effects of the IXTOC I oil spill on an intertidal region of Padre Island, the Bay of Campeche. They found the oil created a tar reef, which decreased the total number of infaunal organisms around the reef when compared with the prespill community. Some species were completely absent after the spill. Chapman and Adams (1984) summarized data collected on coastal bird populations before and after the IXTOC I oil spill. They discussed the seasonal fluctuations in habitat and species distribution and documented the daily natural history of many of the species that inhabit the park.

Carls et al. (1995) examined soil samples from oil and gas drilling sites at PAIS for petroleum or drilling-related substances. They found elevated levels of heavy metals, sodium, salinity, pH and/or petroleum hydrocarbons on most sites. These levels did not pose an immediate threat but may lead to problems due to long-term cumulative effects. Sharma et al. (1997) examined 52 sites in the upper Laguna Madre for hydrocarbon contamination of sediments. Anthropogenic sources were implicated in both polycyclic aromatic and aliphatic hydrocarbon contamination while biogenic sources were also a probable source for some of the aliphatic contamination. Sharman et al. (2000a) examined the sediments of Nueces Bay for hydrocarbon contamination.

Withers et al. (1995) collected benthic invertebrate samples from intertidal and subtidal areas along PAIS to determine if the *M/T Berge Banker* oil spill or cleanup had any effect on abundance or community structure. Changes in community structure were detected for some areas sampled, likely due to cleanup, but were not expected to be long-lived. Barnes conducted a study on the hydrocarbon levels in the sediments within the park. Samples were taken from the dredge material, natural islands, and shoreline of Laguna Madre. With the exception of samples taken from an abandoned oil and gas production facility, no elevated levels of contamination were detected (Barnes 1995).

Trash

Peart (1987) conducted a study the amount, rate and seasonal effects in which PAIS beach debris accumulated in three zones: northward longshore drift, convergence and southward drift. Bieniek (1989) reported on the type and abundance of debris collected at test sites during a two-year study at PAIS. He found that plastic made up the bulk of the debris. Additional trash categories were added in the spring to include all man-made debris, including chemical hydrocarbons, plastic packaging materials, wood, glass, metal, leather, paper and cloth (Bjork 1989). A five-year study monitoring the marine debris on eight coastal national parks began in 1989 (Cole et al. 1990). Annual reports discussed the type of debris found, amount of plastic and non-plastic, seasonal effects and the quality of the debris for each site. In 1991, PAIS began daily debris surveys to supplement the seasonal effort and determine the accuracy of the seasonal surveys (Echols & Miller 1992). In 2003, Miller and Jones completed a summary of 10 years of marine debris research. Likely point sources for pollution and the percentage of the debris

associated with each source was documented (D. L. Echols, personal communication, 16 September 2004).

Pesticides

King et al. (1977) discussed the population decline of the Brown Pelican (*Pelecanus occidentalis*) nesting in Corpus Christi Bay from 1918 to 1964. King et al. (1978) examined aquatic bird eggs along the coast of Texas during 1970 and found significant decreases in shell thickness for 15 of the 22 species with DDT compounds found in all eggs. Five species in the study had declining populations.

Ward et al. (1978) collected blood samples from Peregrine Falcons that migrated through South Padre Island during the spring and examined their pesticide contamination levels. Hunt et al. (1979) conducted a study on the migratory patterns of Arctic Peregrine Falcons that were banded and fitted with radio transmitters at PAIS. Blood samples from these birds were tested for concentrations of pesticides ingested in their Meso and South American wintering grounds. Henny et al. (1982) tested the blood of Peregrine Falcons during spring and fall migrations on Padre Island from 1976 to 1980. They found that the organochlorine pesticide DDE bioaccumulated in the birds while on their Latin American wintering grounds, but this threat began to lessen in 1979. They collected additional samples in 1984 and compared those with the 1982 study (Henny et al. 1985). In a later survey, Henny et al. (1996) found a continuation of the DDE reduction. No other residual organochlorine pesticides previously detected were found in the 1994 samples. However, three-quarters of the females caught in 1994 had detectable levels of PCBs. Maechtle (1991) used data from trapping and banding, re-sightings and returns, blood samples and pesticide contamination records at PAIS to determine the population trends for Peregrine Falcons. Data suggests that Arctic populations may be recovering.

Custer and Mitchell (1991) examined Willet carcasses collected from agricultural drainages for contamination by organophosphates and trace elements. Although detections of the various chemicals and minerals were found in the birds, all concentrations were below known toxic levels.

Michot et al. (1994) examined Redhead carcasses for organochlorine, hydrocarbon and trace element contamination residues either non-detected or below record toxic levels in all samples. DDE was the only organochloride detected and it was below toxic levels.

Mora (1996b) collected eggs from four species of wading birds in the lower Laguna Madre and tested them for organochlorine compounds and trace metals. Although 10 heavy metals were detected in 90% of the eggs, levels were not high enough for concern. The DDE levels of the current study were lower than those detected during the 1970's and 1980's. Mora (1996a) also examined the levels of PCBs in wading bird eggs and found that the levels were correlated with the diets of the birds. PCB levels were lower than rates known to affect reproduction.

Stickle and Zhang (2003) examined the instance of imposex in Hay's rock-shell (*Stramonita haemastoma*) populations in the Gulf of Mexico and Florida from 1988 to 2000. This development of a penis and vas deferens in the female was caused by an antifouling chemical,

Tributyltin, which had been banned in the US since 1988. Initial levels were high on South Padre Island but declined over time.

DISTURBANCE

Cattle grazing

Price and Gunter (n.d.) examined possible causes and effects of geological and biological changes in the flora and fauna of coastal prairies such as PAIS. They discussed drought, cattle grazing, sedimentation in the local estuaries and immigration of species such as nine-banded armadillo (*Dasypus novemcinctus texanus*), Greater Roadrunner (*Geococcyx californianus*), Plain Chachalaca (*Ortalis vetula*) and White-winged Dove (*Zenaida asiatica*). Overgrazing of the coastal land has led to a decrease in vegetative cover, an increase in runoff and evaporation, and a lower water table. They discussed the possibility that overgrazing contributes to climatic changes that create arid conditions.

Rechenthin and Passey (1967) described the vegetation on PAIS prior to the elimination of cattle from the area. Grazing had occurred continuously on the island for 150 years until 1971, when cattle were removed. Higginbotham (1972) and Higginbotham and Drawe (1971) described a study that established permanent transects to examine changes in the vegetative characteristics of PAIS as plant communities returned to pre-grazing conditions. He gave detailed methodology and species lists for three of the study areas. Kattner (1973) examined the secondary succession of vegetation on PAIS after cattle grazing was eliminated. Vegetation transects were sampled on a 5-year interval over a 15-year period. Drawe (1990) discussed later findings of this same study. Although it was felt that the vegetation would quickly advance to its climatic stage, species composition changed very little over the 15-year period. The harsh environment and poor soils were listed as possible reasons for the lack of succession.

Through the use of maps and descriptive accounts, Prouty (1989a) examined the changes on the inland side of PAIS that have occurred since the 19th century. She found that overgrazing and drought denuded a once largely vegetated island and increased accumulation of sand in Laguna Madre. Because grazing was phased out on the island, vegetation has rebounded and consequently reduced sand flow and caused a shoreline retreat at Laguna Madre.

Erosion

Morton and Pieper (1977) examined historic shoreline changes that have occurred on Mustang Island and Padre Island through the use of aerial photographs, historic charts and maps. They discussed previous studies that had been conducted and the condition of the beaches and vegetation line as they related to storms, soil erosion and accretion, and climate.

Giardino et al. (1982) discussed the erosion of South Padre Island that was caused by daily wave action as well as major storms and hurricanes. Using ground surveys and aerial photographs they examined the extent of the erosion due to major hurricanes such as Hurricanes Allen in 1980 and Beulah in 1970. Based on the moderate to heavy erosion they detected, they

recommended reexamining the required setback for waterfront developments. Giardino et al. (1984) also examined aerial photographs taken before and after Hurricane Allen to determine the effect on the morphology of Padre Island. They found that the shoreline was altered on both the Gulf and the inland side of the island. Water broke through and overflowed dune walls and flowed along roadways from the Gulf to the lagoon and caused erosion along these roads. They also discussed the development of the island that has occurred, especially since the 1970's, and warn that future development of the island should acknowledge these dynamic forces of the island environment.

Prouty (1989b) and Prouty and Prouty (1988a&b) used topographic surveys in dune fields to examine the erosion and deposition that occurred on BIB during a short-term (18-month) study. They examined the effects of vegetation, wind, currents and dune migration on the erosion/deposition of sand and recommended that testing continue on a regular basis. Prouty (1989) conducted a study to examine reasons for accretion and erosion of sand along PAIS. He found that the beach 30 miles south of Malaquite Beach (Mile 30) had the coarsest sand and steepest slope of the four areas sampled. The coarse sand allows for water to percolate through the sand and does not erode, which leads to the accumulation of sediments and the steep profile. Prouty and Prouty (1989) took information from previous surveys and documented the shoreline profile and profile data for 12 beaches in the BIB. This guide was created as a model for future erosion/accretion monitoring at PAIS. Prouty and Prouty (1991) conducted a follow up survey of the previous dune survey using established protocols. They discussed short-term changes in accretion and erosion, shoreline changes, and gave management and monitoring recommendations.

Koepsell et al. (1989) analyzed the erosion rate of South Padre Island using ground surveys and aerial and space shuttle photography. They found that the whole Gulf Coast side of South Padre was swiftly eroding but the middle section was occurring at the highest rate.

Fire

Drawe and Kattner (1978) conducted a study that examined vegetation regrowth in response to mowing and burning on PAIS. Lonard et al. (2003) investigated the recovery of plant richness, diversity and abundance from a 1999 wild fire on tidal flats in PAIS. Richness and diversity returned quickly but cover and biomass recovery was much slower. In a similar study, Lonard et al. (In press) examined the effects of this fire in a grassland. Again, species richness and diversity recovered quickly, as did evenness in both flats and secondary dunes. Vegetative cover was slower to return, but after one year it equaled the cover on the dune non-burn sites and exceeded the non-burned sites on the flats.

Vehicle or pedestrian

Teerling (1970) conducted a study of the effect of human activity, weather and season on the density and activity of ghost crabs on the forebeach of PAIS. She found that greater densities of ghost crabs occurred in areas with less people.

Behrens et al. (1974) compared the amount of sand that accumulated in areas where vehicles were allowed versus areas where vehicles were off limits. They found the amount of sand accumulated was related to the width of the vegetation on the backshore. The conclusion did not address the effect of human impact. Behrens et al. (1976) examined the differences in floral density and variety found on beaches with heavy and light vehicular traffic and found, not surprisingly, that areas with heavy traffic displayed a decline in density and species richness. Of particular interest was the decline in grasses. They also found that vegetated areas of the beach continued to grow, but volume was lost on that part of the beach closest to the sea. Vehicular traffic had less of an effect on main foredune ridges of shell beaches due to the stabilization of the shell pavement surface. The backshore was more susceptible to storm erosion due to the reduction in density of sand binding plants caused by heavy vehicular traffic. Pedestrian traffic on the backshore was much less detrimental and did not cause serious damage to the dunes.

McAtee and Drawe (1974) discussed the preliminary results of their study to examine the effects of high traffic, both vehicular and foot, on the beach and foredunes of PAIS. They examined a variety of components in the system including the number of visitors, vegetation cover and the environmental attributes of the soil, water and atmosphere. In his thesis, McAtee (1975) expanded this study and discussed the amount of vegetation in beach and foredunes of PAIS to ascertain an appropriate amount of usage that would balance recreation and stability of the environment. McAtee and Drawe (1981) further discussed damage caused by vehicular and pedestrian traffic to the vegetation in beach and foredune areas on North Padre Island and PAIS. They found that weather, salinity, evaporation and conditions in the atmosphere also affected these habitats.

Baccus and Horton (1979) studied the variation in vegetation between dunes on PAIS that received different levels of anthropogenic disturbances. They found that vehicles had the greatest effect on lowering the amount of vegetation on a beach. Again, pedestrians also had a negative effect, but less than that of the vehicular traffic. Additionally, beaches with vehicular traffic were not as stable in storm events. They also created a vegetation map of the park based on the geotypes.

Blum and Jones (1985) examined and compared the density and complexity of foredune vegetation on five sites on North Padre Island. Their findings suggested that differences were due to the amount of traffic each site received.

Wicksten et al. (1987) collected baseline information on invertebrate populations inhabiting two beaches that varied in the amount of traffic they received. They examined the diversity and distribution of species, effect of seasons and physical parameters such as tides, temperatures, salinity, foredune growth, traffic and weather.

Judd et al (1989) examined the effects of vehicles on the secondary dunes at PAIS. They found that All Terrain Vehicles (ATV's) caused the most damage and this damage decreased with increased distance from the ATV rental shop.

Drawe and Ortega (1996) examined the effect of the impact of vehicles from geophysical seismic surveys on vegetation on PAIS. The most damage was to areas with low vegetation cover. However they found vegetation returned to its pre-disturbance diversity within two years.

Lonard et al. (1999) examined the use of aerial multispectral digital videography and line intercept ground truthing to determine cover and identify species. In a comparison of the current vegetation and that found by Judd et al. (1977), Lonard et al. found that the dominant species of the backshore had changed and species diversity had decreased on the backshore and primary dunes largely due to vehicular traffic.

Hurricanes

Judd and Sides (1983) examined the effects of Hurricane Allen on the near-shore vegetation on South Padre. They found that only three of the eight species documented prior to the storm still occurred on the backshore zone. The storms leveled the foredunes but taller dunes showed less adverse affects. Distribution of fiddle-leaf morning glory (*Ipomoea stolonifera*) and little bluestem (*Schizachyrium scoparium*) also was effected. Judd et al. (1991) studied the recovery of *S. scoparium* from a hurricane simulation.

Park maintenance

Engelhard and Withers (1997) described the effects of mechanical beach raking on birds, insects and crustacean populations in the upper intertidal zone at PAIS. The greatest effect on macrofauna was seen in the three days following the raking. After two weeks, there was no noticeable change in macrofaunal populations. Due to the importance of this area or wrackline for shorebird feeding, they recommended stopping the raking in August to allow invertebrate populations to rebound in time for fall migration.

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Appendix A. Federal and State Listed Species that have been documented in or are possible inhabitants of PAIS. List of species was adapted from the 1996 Resource Management Plan, PAIS website, and past park research (Duran 2004; Padre Island National Seashore 1996, 2004).

Species	Scientific name	Status ¹
Plants		
Roughseed Sea-purslane	<i>Sesuvium trianthemoides</i>	Texas State Possibly Extirpated
Mammals		
No documented or suspected species		
Reptiles		
loggerhead turtle	<i>Caretta Caretta</i>	Federally and Texas State Threatened
leatherback turtle	<i>Dermochelys coriacea</i>	Federally and Texas State Endangered
Kemp's Ridley sea turtle	<i>Lepidochelys kempt</i>	Federally and Texas State Endangered
green sea turtle	<i>Chelonia mydas</i>	Federally and Texas State Threatened
hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Federally and Texas State Endangered
Texas scarlet snake	<i>Cemophora coccinea lineri</i>	Texas Threatened
American alligator	<i>Alligator mississippiensis</i>	Federally Threatened (S/A)
keeled earless lizard	<i>Holbrookia propinqua</i>	Texas State Rare
Texas horned lizard	<i>Phrynosoma cornutum</i>	Federally SOC; Texas Threatened
Texas indigo snake	<i>Drymarchon corais erebennus</i>	Texas Threatened
Amphibians		
No documented or suspected species		
Birds		
Piping Plover	<i>Charadrius melodus</i>	Federally and Texas State Threatened
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Federally Threatened (Proposed for delisting); Texas State Threatened
American Peregrine Falcon	<i>Falco peregrinus</i>	Texas Endangered
Arctic Peregrine Falcon	<i>Falco peregrinus tundrius</i>	Texas Threatened
White-tailed Hawk	<i>Buteo albicaudatus</i>	Texas Threatened
Ferruginous Hawk	<i>Buteo regalis</i>	Federally SOC
Snowy Plover	<i>Charadrius alexandrinus</i>	Texas State Imperiled*
Interior Least Tern	<i>Sterna antillarum</i>	Federally and Texas State Endangered
Sooty Tern	<i>Sterna fuscata</i>	Texas State Threatened
Long-billed Curlew	<i>Numenius americanus</i>	Texas State Rare*
Brown Pelican	<i>Pelecanus occidentalis</i>	Federally and Texas State Endangered
Wood Stork	<i>Mycteria americana</i>	State Threatened
Reddish Egret	<i>Egretta rufescens</i>	Federally SOC; State Threatened
White-faced Ibis	<i>Plegadis chihi</i>	Federally SOC; State Threatened
Cerulean Warbler	<i>Dendroica cerulea</i>	Federally SOC
Black Tern	<i>Chlidonias niger</i>	Federally SOC
Northern Aplomado Falcon	<i>Falco femoralis septentrionalis</i>	Federally and Texas State Endangered
American Swallow-tailed Kite	<i>Elanoides forficatus</i>	Texas Threatened
Black-capped Vireo	<i>Vireo atricapillus</i>	Federally and State Endangered
Tropical Parula	<i>Parula pitiayumi</i>	Federally SOC; Texas Threatened
Loggerhead Shrike	<i>Lanius ludovicianus</i>	Federally SOC
Fish		
No documented or suspected species		
Invertebrates		
No documented or suspected species		

¹ S/A - similarity of appearance to a threatened taxon; SOC - Species of Concern; * breeding population only

Appendix B. Management issues and concerns that face PAIS and how these issues may affect the park's resources

Management Issues	Priority	Significant Natural Resources Impacted	Monitoring Questions
Climate Change	HIGH	All natural resources	How will rising sea levels affect the park? How will higher temperatures affect native species? How vulnerable are park resources to climate changes?
Data Gaps	HIGH	Mammals, Fish, Invertebrates, Coastal Processes, Insects, subsidence, groundwater flow, nutrient cycling	No information
Erosion	HIGH	Soils, water, grasslands, wetlands, T&E species, vegetation, dunes and other natural resources	Has the erosion increased with driving on beaches and park development? How are the specific habitats of the park affected by erosion? What is the current and historic sediment budget? Are there areas of erosion? How has the shoreline changed? Is erosion affecting emerged aquatic vegetation?
Exotics (Plants)	HIGH	Native vegetation composition, biological diversity, and other important park resources. The main exotic are Tamrix, bufflegass and Kleberg Bluestem, Brazilian Pepper	What is the extent of exotic infestation? What is the most effective method of control? How does exotic vegetation affect fire ecology? How do exotic species affect habitats of significant natural resources?
Fire Management	HIGH	Vegetative Communities, Threatened and Endangered Species, air quality, sediment quality, exotics, and water quality	How does fire affect the natural resources in the park? What is the fire interval for Padre Island? What are the disadvantages of not maintaining a prescribed burn plan? How does fire affect exotic plant species? To what extent is air quality affected?
Fishing (Rec & Comm)	HIGH	Fish, crustaceans, non-target species	How is the current level of fishing affecting park resources? Are fishermen collecting illegal sized fish? How does commercial fishing outside park boundary affect park resources? Are colonial waterbirds affected by prey availability?
Floodplain protection	HIGH	Hydrology, Water quality, breeding and foraging habitat, migratory bird habitat, soil quality, species diversity, T&E species, Fish	How does development in the park affect wetlands? What wetlands need restoration and what is the best way to restore specific wetlands? How do you ensure hydrology is maintained to support wetlands? How does O&G affect wetlands? What education programs can be included in our wetland management? How have wetlands changed over time?
Migratory Birds	HIGH	Migratory birds, habitats, predatory birds,	How do park activities affect these birds? What are the habitat requirements for migratory birds? How successful are colonial waterbirds in fledging young?
Native Wildlife Reintroductions	HIGH	Kemp's ridley	What affects does driving compaction have on nesting.
Night Sky	HIGH	T&E Species, migratory birds, utilization of habitat	How does the light affect wildlife species? Does light affect migration?

Appendix B. Continued.

Management Issues	Priority	Significant Natural Resources Impacted	Monitoring Questions
Oil/Gas	HIGH	All natural resources are affected.	What threatened and endangered species do oil and gas exploration and production affect? What are the long-term impacts on grassland and wetlands? Are there changes in hydrology, erosion, and compaction due to operations? Are there aquatards that are affected?
Poaching	HIGH	Wildlife	Are poachers adversely affecting the wildlife population? Are poachers using park resources to access adjacent lands to poach wildlife? To what extent does hunting or poaching affect park habitats? What affects do poachers have on vegetation (social traits)
Soundscape	HIGH	Migratory birds, shorebirds, colonial waterbirds, and other wildlife. Seashore is near a naval air station and flyovers are common	How do flyovers affect the wildlife at the park?
T&E Species	HIGH	T&E Species and other wildlife	What affects do park activities have on T&E species? What is the static of current T&E species population? Are certain habitats used by T&E more than other habitats?
Viewscape	HIGH	Wildlife, vegetation, soil and water quality, habitats	What affect does current park development have on the viewscape? How can future development possibly affect the view? What are the impacts associated with this activity on native wildlife?
Visitor Overuse	HIGH	All natural resources	Do visitors impact the nesting success of the Kemp's Ridley Sea Turtle? Does driving on the beach speed up the erosion process? How have park habitats been affected by driving? What are the impacts of visitors on natural?
Water Quality (Surface) (Compliance with Clean Water Act)	HIGH	All natural resources are affected by poor water quality	What are the levels of nutrients, inorganics, and organics in the water? What are the interactions between surface water and groundwater? What degree is water quality affected by atmospheric deposition? What effect does dredging have on Laguna Madre water quality?
Wetlands	HIGH	Hydrology, Water quality, breeding and foraging habitat, migratory bird habitat, soil quality, species diversity, T&E species, Fish. The entire park is in a 50-year floodplain.	How does development in the park affect wetlands? What wetlands need restoration and what is the best way to restore specific wetlands? How do you ensure hydrology is maintained to support wetlands? How does O&G affect wetlands? What education programs can be included in our wetland management? How have wetlands changed over time?

Appendix B. Continued.

Management Issues	Priority	Significant Natural Resources Impacted	Monitoring Questions
Adjacent Landuse	MED	Wildlife, viewscape, nightscape, exotic species, and soundscape	Is TGLO going to continue the present use of the adjacent land? What is the impact of adjacent landuse on park resources?
Hunting & Trapping	MED	Legal hunting of waterfowl in park waters /trapping on parklands is not permitted. Hunting is permitted on lands adjacent to the park. White-tailed deer and waterfowl, vegetation (social Trails), wind tidal flats (off road driving)	What are current populations and trends of game species? Does hunting on the lands adjacent to the park affect wildlife numbers in the park?
Subsidence	MED	Park habitats, hydrology, water quality, wildlife	Is subsidence occurring in the park? What is causing subsidence? Where is it occurring? What species are more susceptible?
Water Quality (Ground)	MED	Soils, vegetation, possible wetlands, possible springs	How clean is the park's groundwater? Is there contamination of groundwater at oil and gas sites? Are wetland habitats dependent on groundwater? What direction does the GW travel and how fast?
Water Quantity (Surface Water)	MED	Wetlands and wetland communities, groundwater recharge	Has park and local development changed the surface water regime (overland flow, retention, etc.)? What effect is the increased volume of freshwater runoff having on estuarine and marine systems? Are aquifers being adequately recharged?
Outside Development	MED/LOW	Wildlife, viewscape, nightscape, exotic species, and soundscape	See adjacent landuse category. How does the growing development on the Island affect the habitat range for park wildlife? Is the growing urban area pushing all wildlife on the Island into the park? If so, does the park have the carrying capacity to sustain the wildlife? Is urban development causing exotic species to enter the park boundaries? How does the growing urban area affect the erosion of island resources?
Air Quality (Compliance with Clean Air Act)	LOW	Poor air quality could be detrimental to all natural resources (i.e. water quality, soils), vegetation, and wildlife	What are the levels of pollutants in the air? How does it affect the viewshed? Where do pollutants come from? How does atmospheric deposition alter park habitats?
Forest pests/Diseases	LOW	NA	NA
Genetic Contamination	LOW	Native species	Are the three oak mottes genetically different with each other and the mainland? Are there currently hybrids species on parklands? Is there the possibility of hybridization occurring?
Mining	LOW	NA	NA
Native Pests	LOW	Bird species and habitat composition	What are native park pest populations and do they exist at Padre Island? Are park pest populations are stable?

Appendix B. Continued.

Management Issues	Priority	Significant Natural Resources Impacted	Monitoring Questions
Native Species Overpopulation	LOW	Wildlife, vegetation, grassland and wetland habitats	Are any native species increasing to a number that may have negative impacts on park resources? How can the park prevent population increases to protect resources?
Native Vegetation Restoration	LOW	Wildlife habitat, T&E species, native vegetation, water quality, soil quality, erosion, and other natural resources	What methods should be used to eliminate exotic plant species so native species can recolonize? Is planted native vegetation being established? Are “native” vegetation species genetically appropriate?
Non-NPS/ Inholding Issues	LOW	T&E Species, wetlands, soil quality, wildlife. a small-undeveloped area of the park is privately owned, and is surrounded by undeveloped parkland. This area is treated and managed like parklands.	NA
Right-of-ways/Easements: one in park	LOW	Vegetation	Impact of activity and development in right-of-ways
Slope Failure	LOW	Soils, vegetation, water quality	Are soil types and slopes sufficient to prevent slope failure?
Water Quantity (Groundwater)	LOW	NA	NA
With/In Park Development	LOW	All natural resources are affected	What are the impacts caused by park development? How can the impacts be minimized?
Exotics (Animals)	LOW	Feral cats and fire ants affect colonial waterbird nesting on spoil island within park boundaries, small mammals, vegetation communities. Feral Cats, Africanized Honeybees, Nilgai, exotic fire ants are the main species	To do what extent do feral cats and fire ants affect colonial waterbirds? How are exotic fire ants affecting native fire ants?

GIS DATA, DATASETS

A list of available spatial and non-spatial data is provided for the park. Data have been organized into the following groups: GIS data, non-GIS digital maps, hardcopy maps, digital databases, digital publications, NatureBib maps, and abbreviations. GIS data have been further separated into three categories: park specific or local, statewide, and nation-wide. A unique identifier has been given to each line of data as follows: “X_#”, where “X” is a letter describing the data type (L=local GIS, S=Statewide GIS, N=Nationwide GIS, D=database) and “#” is a unique number. Basic information is provided to allow quick review of the publicly available data, including the title of the data and the organization from which the data are available. To view more extensive details about the data, an EXCEL workbook (“Digital Data”) has been provided. The EXCEL workbook includes several datasheets for each of the aforementioned data categories. Among some of the additional details provided in the EXCEL workbook are partial metadata, web addresses, and descriptions of the data. Blank fields within the EXCEL workbook represent information that were not readily available, but can be gathered at a later date with a more in depth search of the available metadata.

General Park Information

Zip Code 78480, Corpus Christi, TX

Spatial Extent

Lat	Long
27.55	-97.43
26.55	-97.26

Padre Island National Seashore

Quadrangles

Pita Island
South Bird Island
South Bird Island SE
Point of Rocks
Yarborough Pass
Potrero Cortado
Potrero Lopeno NW
Potrero Lopeno NE
Potrero Lopeno SW
Potrero Lopeno SE
S. of Potrero Lopeno NW
S. of Potrero Lopeno NE
S. of Potrero Lopeno SE

Counties

Willacy
Kennedy
Kleberg
Nueces

North Padre Island to Port Aransas

Quadrangles

Crane Islands SW
Crane Islands NW
Port Ingleside
Port Aransas

Counties

Aransas
Nueces
San Patricio
Kleberg

South Padre Island to Port Isabel

Quadrangles

S. of Potrero Lopeno SE
Green Island
No. of Port Isabel NW
No. of Port Isabel SW

General Park Information

Three Islands
Port Isabel NW
Port Isabel

Counties

Kenedy
Willacy
Cameron

Watersheds	HUC
South Laguna Madre	12110208
Central Laguna Madre	12110207
North Laguna Madre	12110203
Baffin Bay	12110205
South Corpus Christi Bay	12110202

Soil data available for all counties except Kenedy and Kleberg

Note: LIDAR data for Texas is only available for area: 29.94N 29.005S -94.8647W - 93.7988E. This is only a 19km stretch of the coastline from Port Arthur, south, which includes the Galveston Bay, but not PAIS. This LIDAR data can be downloaded from: NOAA LIDAR data retrieval tool at http://www.csc.noaa.gov/cgi-bin/crs/tcm/ldart_start.pl. The Bureau of Economic Geology has several reports for download on Texas coastal change.

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_1	TNRIS	USGS	Port Aransas NE	DOQQ	1:12,000	Raster	1 m
L_2	TNRIS	USGS	Port Aransas NE	DOQQ	1:12,000	Raster	10 m
L_3	TNRIS	USGS	Port Aransas NE	DOQQ	1:12,000	Raster	30 m
L_4	TNRIS	USGS	Port Aransas NW	DOQQ	1:12,000	Raster	1 m
L_5	TNRIS	USGS	Port Aransas NW	DOQQ	1:12,000	Raster	10 m
L_6	TNRIS	USGS	Port Aransas NW	DOQQ	1:12,000	Raster	30 m
L_7	TNRIS	USGS	Port Aransas SW	DOQQ	1:12,000	Raster	1 m
L_8	TNRIS	USGS	Port Aransas SW	DOQQ	1:12,000	Raster	10 m
L_9	TNRIS	USGS	Port Aransas SW	DOQQ	1:12,000	Raster	30 m
L_10	TNRIS	USGS	Port Aransas	DRG	1:24,000	Vector	
L_11	TNRIS	USGS	Port Aransas	DRG	1:100,000	Vector	
L_12	TNRIS	USGS	Port Aransas	DRG	1:250,000	Vector	
L_13	TNRIS	USGS	Port Aransas	Hypsography	1:24,000	Vector	
L14	TNRIS	USGS	Port Ingleside NE	DOQQ	1:12,000	Raster	1 m
L15	TNRIS	USGS	Port Ingleside NE	DOQQ	1:12,000	Raster	10 m
L16	TNRIS	USGS	Port Ingleside NE	DOQQ	1:12,000	Raster	30 m
L17	TNRIS	USGS	Port Ingleside NW	DOQQ	1:12,000	Raster	1 m
L18	TNRIS	USGS	Port Ingleside NW	DOQQ	1:12,000	Raster	10 m
L19	TNRIS	USGS	Port Ingleside NW	DOQQ	1:12,000	Raster	30 m
L20	TNRIS	USGS	Port Ingleside SE	DOQQ	1:12,000	Raster	1 m
L21	TNRIS	USGS	Port Ingleside SE	DOQQ	1:12,000	Raster	10 m
L22	TNRIS	USGS	Port Ingleside SE	DOQQ	1:12,000	Raster	30 m
L23	TNRIS	USGS	Port Ingleside SW	DOQQ	1:12,000	Raster	1 m
L24	TNRIS	USGS	Port Ingleside SW	DOQQ	1:12,000	Raster	10 m
L25	TNRIS	USGS	Port Ingleside SW	DOQQ	1:12,000	Raster	30 m
L26	TNRIS	USGS	Port Ingleside	DRG	1:24,000	Vector	
L27	TNRIS	USGS	Port Ingleside	DRG	1:100,000	Vector	
L28	TNRIS	USGS	Port Ingleside	DRG	1:250,000	Vector	
L29	TNRIS	USGS	Port Ingleside	Hypsography	1:24,000	Vector	
L_30	TNRIS	USGS	Crane Islands NW NE	DOQQ	1:12,000	Raster	1 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_31	TNRIS	USGS	Crane Islands NW NE	DOQQ	1:12,000	Raster	10 m
L_32	TNRIS	USGS	Crane Islands NW NE	DOQQ	1:12,000	Raster	30 m
L_33	TNRIS	USGS	Crane Islands NW NW	DOQQ	1:12,000	Raster	1 m
L_34	TNRIS	USGS	Crane Islands NW NW	DOQQ	1:12,000	Raster	10 m
L_35	TNRIS	USGS	Crane Islands NW NW	DOQQ	1:12,000	Raster	30 m
L_36	TNRIS	USGS	Crane Islands NW SE	DOQQ	1:12,000	Raster	1 m
L_37	TNRIS	USGS	Crane Islands NW SE	DOQQ	1:12,000	Raster	10 m
L_38	TNRIS	USGS	Crane Islands NW SE	DOQQ	1:12,000	Raster	30 m
L_39	TNRIS	USGS	Crane Islands NW SW	DOQQ	1:12,000	Raster	1 m
L_40	TNRIS	USGS	Crane Islands NW SW	DOQQ	1:12,000	Raster	10 m
L_41	TNRIS	USGS	Crane Islands NW SW	DOQQ	1:12,000	Raster	30 m
L_42	TNRIS	USGS	Crane Islands NW	DRG	1:24,000	Vector	
L_43	TNRIS	USGS	Crane Islands NW	DRG	1:100,000	Vector	
L_44	TNRIS	USGS	Crane Islands NW	DRG	1:250,000	Vector	
L_45	TNRIS	USGS	Crane Islands NW	Hypsography	1:24,000	Vector	
L_46	TNRIS	USGS	Crane Islands SW NW	DOQQ	1:12,000	Raster	1 m
L_47	TNRIS	USGS	Crane Islands SW NW	DOQQ	1:12,000	Raster	10 m
L_48	TNRIS	USGS	Crane Islands SW NW	DOQQ	1:12,000	Raster	30 m
L_49	TNRIS	USGS	Crane Islands SW SW	DOQQ	1:12,000	Raster	1 m
L_50	TNRIS	USGS	Crane Islands SW SW	DOQQ	1:12,000	Raster	10 m
L_51	TNRIS	USGS	Crane Islands SW SW	DOQQ	1:12,000	Raster	30 m
L_52	TNRIS	USGS	Crane Islands SW	DRG	1:24,000	Vector	
L_53	TNRIS	USGS	Crane Islands SW	DRG	1:100,000	Vector	
L_54	TNRIS	USGS	Crane Islands SW	DRG	1:250,000	Vector	
L_55	TNRIS	USGS	Crane Islands SW	Hypsography	1:24,000	Vector	
L_56	TNRIS	USGS	Pita Island NE	DOQQ	1:12,000	Raster	1 m
L_57	TNRIS	USGS	Pita Island NE	DOQQ	1:12,000	Raster	10 m
L_58	TNRIS	USGS	Pita Island NE	DOQQ	1:12,000	Raster	30 m
L_59	TNRIS	USGS	Pita Island NW	DOQQ	1:12,000	Raster	1 m
L_60	TNRIS	USGS	Pita Island NW	DOQQ	1:12,000	Raster	10 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_61	TNRIS	USGS	Pita Island NW	DOQQ	1:12,000	Raster	30 m
L_62	TNRIS	USGS	Pita Island SE	DOQQ	1:12,000	Raster	1 m
L_63	TNRIS	USGS	Pita Island SE	DOQQ	1:12,000	Raster	10 m
L_64	TNRIS	USGS	Pita Island SE	DOQQ	1:12,000	Raster	30 m
L_65	TNRIS	USGS	Pita Island SW	DOQQ	1:12,000	Raster	1 m
L_66	TNRIS	USGS	Pita Island SW	DOQQ	1:12,000	Raster	10 m
L_67	TNRIS	USGS	Pita Island SW	DOQQ	1:12,000	Raster	30 m
L_68	TNRIS	USGS	Pita Island	DRG	1:24,000	Vector	
L_69	TNRIS	USGS	Pita Island	DRG	1:100,000	Vector	
L_70	TNRIS	USGS	Pita Island	DRG	1:250,000	Vector	
L_71	TNRIS	USGS	Pita Island	Hypsography	1:24,000	Vector	
L_72	TNRIS	USGS	South Bird Island NE	DOQQ	1:12,000	Raster	1 m
L_73	TNRIS	USGS	South Bird Island NE	DOQQ	1:12,000	Raster	10 m
L_74	TNRIS	USGS	South Bird Island NE	DOQQ	1:12,000	Raster	30 m
L_75	TNRIS	USGS	South Bird Island NW	DOQQ	1:12,000	Raster	1 m
L_76	TNRIS	USGS	South Bird Island NW	DOQQ	1:12,000	Raster	10 m
L_77	TNRIS	USGS	South Bird Island NW	DOQQ	1:12,000	Raster	30 m
L_78	TNRIS	USGS	South Bird Island SE	DOQQ	1:12,000	Raster	1 m
L_79	TNRIS	USGS	South Bird Island SE	DOQQ	1:12,000	Raster	10 m
L_80	TNRIS	USGS	South Bird Island SE	DOQQ	1:12,000	Raster	30 m
L_81	TNRIS	USGS	South Bird Island SW	DOQQ	1:12,000	Raster	1 m
L_82	TNRIS	USGS	South Bird Island SW	DOQQ	1:12,000	Raster	10 m
L_83	TNRIS	USGS	South Bird Island SW	DOQQ	1:12,000	Raster	30 m
L_84	TNRIS	USGS	South Bird Island	DRG	1:24,000	Vector	
L_85	TNRIS	USGS	South Bird Island	DRG	1:100,000	Vector	
L_86	TNRIS	USGS	South Bird Island	DRG	1:250,000	Vector	
L_87	TNRIS	USGS	South Bird Island	Hypsography	1:24,000	Vector	
L_88	TNRIS	USGS	South Bird Island	DEM	1:24,000	Raster	30 m
L_89	TNRIS	USGS	South Bird Island SE NW	DOQQ	1:12,000	Raster	1 m
L_90	TNRIS	USGS	South Bird Island SE NW	DOQQ	1:12,000	Raster	10 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_91	TNRIS	USGS	South Bird Island SE NW	DOQQ	1:12,000	Raster	30 m
L_92	TNRIS	USGS	South Bird Island SE SW	DOQQ	1:12,000	Raster	1 m
L_93	TNRIS	USGS	South Bird Island SE SW	DOQQ	1:12,000	Raster	10 m
L_94	TNRIS	USGS	South Bird Island SE SW	DOQQ	1:12,000	Raster	30 m
L_95	TNRIS	USGS	South Bird Island SE	DRG	1:24,000	Vector	
L_96	TNRIS	USGS	South Bird Island SE	DRG	1:100,000	Vector	
L_97	TNRIS	USGS	South Bird Island SE	DRG	1:250,000	Vector	
L_98	TNRIS	USGS	South Bird Island SE	Hypsography	1:24,000	Vector	
L_99	TNRIS	USGS	South Bird Island SE	DEM	1:24,000	Raster	30 m
L_100	TNRIS	USGS	Point of Rocks NE	DOQQ	1:12,000	Raster	1 m
L_101	TNRIS	USGS	Point of Rocks NE	DOQQ	1:12,000	Raster	10 m
L_102	TNRIS	USGS	Point of Rocks NE	DOQQ	1:12,000	Raster	30 m
L_103	TNRIS	USGS	Point of Rocks NW	DOQQ	1:12,000	Raster	1 m
L_104	TNRIS	USGS	Point of Rocks NW	DOQQ	1:12,000	Raster	10 m
L_105	TNRIS	USGS	Point of Rocks NW	DOQQ	1:12,000	Raster	30 m
L_106	TNRIS	USGS	Point of Rocks SE	DOQQ	1:12,000	Raster	1 m
L_107	TNRIS	USGS	Point of Rocks SE	DOQQ	1:12,000	Raster	10 m
L_108	TNRIS	USGS	Point of Rocks SE	DOQQ	1:12,000	Raster	30 m
L_109	TNRIS	USGS	Point of Rocks SW	DOQQ	1:12,000	Raster	1 m
L_110	TNRIS	USGS	Point of Rocks SW	DOQQ	1:12,000	Raster	10 m
L_111	TNRIS	USGS	Point of Rocks SW	DOQQ	1:12,000	Raster	30 m
L_112	TNRIS	USGS	Point of Rocks	DRG	1:24,000	Vector	
L_113	TNRIS	USGS	Point of Rocks	DRG	1:100,000	Vector	
L_114	TNRIS	USGS	Point of Rocks	DRG	1:250,000	Vector	
L_115	TNRIS	USGS	Point of Rocks	Hypsography	1:24,000	Vector	
L_116	TNRIS	USGS	Point of Rocks	DEM	1:24,000	Raster	30 m
L_117	TNRIS	USGS	Yarborough Pass NE	DOQQ	1:12,000	Raster	1 m
L_118	TNRIS	USGS	Yarborough Pass NE	DOQQ	1:12,000	Raster	10 m
L_119	TNRIS	USGS	Yarborough Pass NE	DOQQ	1:12,000	Raster	30 m
L_120	TNRIS	USGS	Yarborough Pass NW	DOQQ	1:12,000	Raster	1 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_121	TNRIS	USGS	Yarborough Pass NW	DOQQ	1:12,000	Raster	10 m
L_122	TNRIS	USGS	Yarborough Pass NW	DOQQ	1:12,000	Raster	30 m
L_123	TNRIS	USGS	Yarborough Pass SE	DOQQ	1:12,000	Raster	1 m
L_124	TNRIS	USGS	Yarborough Pass SE	DOQQ	1:12,000	Raster	10 m
L_125	TNRIS	USGS	Yarborough Pass SE	DOQQ	1:12,000	Raster	30 m
L_126	TNRIS	USGS	Yarborough Pass SW	DOQQ	1:12,000	Raster	1 m
L_127	TNRIS	USGS	Yarborough Pass SW	DOQQ	1:12,000	Raster	10 m
L_128	TNRIS	USGS	Yarborough Pass SW	DOQQ	1:12,000	Raster	30 m
L_129	TNRIS	USGS	Yarborough Pass	DRG	1:24,000	Vector	
L_130	TNRIS	USGS	Yarborough Pass	DRG	1:100,000	Vector	
L_131	TNRIS	USGS	Yarborough Pass	DRG	1:250,000	Vector	
L_132	TNRIS	USGS	Yarborough Pass	Hypsography	1:24,000	Vector	
L_133	TNRIS	USGS	Yarborough Pass	DEM	1:24,000	Raster	30 m
L_134	TNRIS	USGS	Potrero Cortado NE	DOQQ	1:12,000	Raster	1 m
L_135	TNRIS	USGS	Potrero Cortado NE	DOQQ	1:12,000	Raster	10 m
L_136	TNRIS	USGS	Potrero Cortado NE	DOQQ	1:12,000	Raster	30 m
L_137	TNRIS	USGS	Potrero Cortado NW	DOQQ	1:12,000	Raster	1 m
L_138	TNRIS	USGS	Potrero Cortado NW	DOQQ	1:12,000	Raster	10 m
L_139	TNRIS	USGS	Potrero Cortado NW	DOQQ	1:12,000	Raster	30 m
L_140	TNRIS	USGS	Potrero Cortado SE	DOQQ	1:12,000	Raster	1 m
L_141	TNRIS	USGS	Potrero Cortado SE	DOQQ	1:12,000	Raster	10 m
L_142	TNRIS	USGS	Potrero Cortado SE	DOQQ	1:12,000	Raster	30 m
L_143	TNRIS	USGS	Potrero Cortado SW	DOQQ	1:12,000	Raster	1 m
L_144	TNRIS	USGS	Potrero Cortado SW	DOQQ	1:12,000	Raster	10 m
L_145	TNRIS	USGS	Potrero Cortado SW	DOQQ	1:12,000	Raster	30 m
L_146	TNRIS	USGS	Potrero Cortado	DRG	1:24,000	Vector	
L_147	TNRIS	USGS	Potrero Cortado	DRG	1:100,000	Vector	
L_148	TNRIS	USGS	Potrero Cortado	DRG	1:250,000	Vector	
L_149	TNRIS	USGS	Potrero Cortado	Hypsography	1:24,000	Vector	
L_150	TNRIS	USGS	Potrero Cortado	DEM	1:24,000	Raster	30 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_151	TNRIS	USGS	Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	1 m
L_152	TNRIS	USGS	Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	10 m
L_153	TNRIS	USGS	Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	30 m
L_154	TNRIS	USGS	Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	1 m
L_155	TNRIS	USGS	Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	10 m
L_156	TNRIS	USGS	Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	30 m
L_157	TNRIS	USGS	Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	1 m
L_158	TNRIS	USGS	Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	10 m
L_159	TNRIS	USGS	Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	30 m
L_160	TNRIS	USGS	Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	1 m
L_161	TNRIS	USGS	Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	10 m
L_162	TNRIS	USGS	Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	30 m
L_163	TNRIS	USGS	Potrero Lopeno NW	DRG	1:24,000	Vector	
L_164	TNRIS	USGS	Potrero Lopeno NW	DRG	1:100,000	Vector	
L_165	TNRIS	USGS	Potrero Lopeno NW	DRG	1:250,000	Vector	
L_166	TNRIS	USGS	Potrero Lopeno NW	Hypsography	1:24,000	Vector	
L_167	TNRIS	USGS	Potrero Lopeno NW	DEM	1:24,000	Raster	30 m
L_168	TNRIS	USGS	Potrero Lopeno SW NE	DOQQ	1:12,000	Raster	1 m
L_169	TNRIS	USGS	Potrero Lopeno SW NE	DOQQ	1:12,000	Raster	10 m
L_170	TNRIS	USGS	Potrero Lopeno SW NE	DOQQ	1:12,000	Raster	30 m
L_171	TNRIS	USGS	Potrero Lopeno SW NW	DOQQ	1:12,000	Raster	1 m
L_172	TNRIS	USGS	Potrero Lopeno SW NW	DOQQ	1:12,000	Raster	10 m
L_173	TNRIS	USGS	Potrero Lopeno SW NW	DOQQ	1:12,000	Raster	30 m
L_174	TNRIS	USGS	Potrero Lopeno SW SE	DOQQ	1:12,000	Raster	1 m
L_175	TNRIS	USGS	Potrero Lopeno SW SE	DOQQ	1:12,000	Raster	10 m
L_176	TNRIS	USGS	Potrero Lopeno SW SE	DOQQ	1:12,000	Raster	30 m
L_177	TNRIS	USGS	Potrero Lopeno SW SW	DOQQ	1:12,000	Raster	1 m
L_178	TNRIS	USGS	Potrero Lopeno SW SW	DOQQ	1:12,000	Raster	10 m
L_179	TNRIS	USGS	Potrero Lopeno SW SW	DOQQ	1:12,000	Raster	30 m
L_180	TNRIS	USGS	Potrero Lopeno SW	DRG	1:24,000	Vector	
L_181	TNRIS	USGS	Potrero Lopeno SW	DRG	1:100,000	Vector	

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_182	TNRIS	USGS	Potrero Lopeno SW	DRG	1:250,000	Vector	
L_183	TNRIS	USGS	Potrero Lopeno SW	Hypsography	1:24,000	Vector	
L_184	TNRIS	USGS	Potrero Lopeno SW	DEM	1:24,000	Raster	30 m
L_185	TNRIS	USGS	Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	1 m
L_186	TNRIS	USGS	Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	10 m
L_187	TNRIS	USGS	Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	30 m
L_188	TNRIS	USGS	Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	1 m
L_189	TNRIS	USGS	Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	10 m
L_190	TNRIS	USGS	Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	30 m
L_191	TNRIS	USGS	Potrero Lopeno SE	DRG	1:24,000	Vector	
L_192	TNRIS	USGS	Potrero Lopeno SE	DRG	1:100,000	Vector	
L_193	TNRIS	USGS	Potrero Lopeno SE	DRG	1:250,000	Vector	
L_194	TNRIS	USGS	Potrero Lopeno SE	Hypsography	1:24,000	Vector	
L_195	TNRIS	USGS	Potrero Lopeno SE	DEM	1:24,000	Raster	30 m
L_196	TNRIS	USGS	So. of Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	1 m
L_197	TNRIS	USGS	So. of Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	10 m
L_198	TNRIS	USGS	So. of Potrero Lopeno NW NE	DOQQ	1:12,000	Raster	30 m
L_199	TNRIS	USGS	So. of Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	1 m
L_200	TNRIS	USGS	So. of Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	10 m
L_201	TNRIS	USGS	So. of Potrero Lopeno NW NW	DOQQ	1:12,000	Raster	30 m
L_202	TNRIS	USGS	So. of Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	1 m
L_203	TNRIS	USGS	So. of Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	10 m
L_204	TNRIS	USGS	So. of Potrero Lopeno NW SE	DOQQ	1:12,000	Raster	30 m
L_205	TNRIS	USGS	So. of Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	1 m
L_206	TNRIS	USGS	So. of Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	10 m
L_207	TNRIS	USGS	So. of Potrero Lopeno NW SW	DOQQ	1:12,000	Raster	30 m
L_208	TNRIS	USGS	So. of Potrero Lopeno NW	DRG	1:24,000	Vector	
L_209	TNRIS	USGS	So. of Potrero Lopeno NW	DRG	1:100,000	Vector	
L_210	TNRIS	USGS	So. of Potrero Lopeno NW	DRG	1:250,000	Vector	
L_211	TNRIS	USGS	So. of Potrero Lopeno NW	Hypsography	1:24,000	Vector	

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_212	TNRIS	USGS	So. of Potrero Lopeno NW	DEM	1:24,000	Raster	30 m
L_213	TNRIS	USGS	So. of Potrero Lopeno NE NW	DOQQ	1:12,000	Raster	1 m
L_214	TNRIS	USGS	So. of Potrero Lopeno NE NW	DOQQ	1:12,000	Raster	10 m
L_215	TNRIS	USGS	So. of Potrero Lopeno NE NW	DOQQ	1:12,000	Raster	30 m
L_216	TNRIS	USGS	So. of Potrero Lopeno NE SE	DOQQ	1:12,000	Raster	1 m
L_217	TNRIS	USGS	So. of Potrero Lopeno NE SE	DOQQ	1:12,000	Raster	10 m
L_218	TNRIS	USGS	So. of Potrero Lopeno NE SE	DOQQ	1:12,000	Raster	30 m
L_219	TNRIS	USGS	So. of Potrero Lopeno NE SW	DOQQ	1:12,000	Raster	1 m
L_220	TNRIS	USGS	So. of Potrero Lopeno NE SW	DOQQ	1:12,000	Raster	10 m
L_221	TNRIS	USGS	So. of Potrero Lopeno NE SW	DOQQ	1:12,000	Raster	30 m
L_222	TNRIS	USGS	So. of Potrero Lopeno NE	DRG	1:24,000	Vector	
L_223	TNRIS	USGS	So. of Potrero Lopeno NE	DRG	1:100,000	Vector	
L_224	TNRIS	USGS	So. of Potrero Lopeno NE	DRG	1:250,000	Vector	
L_225	TNRIS	USGS	So. of Potrero Lopeno NE	Hypsography	1:24,000	Vector	
L_226	TNRIS	USGS	So. of Potrero Lopeno NE	DEM	1:24,000	Raster	30 m
L_227	TNRIS	USGS	So. of Potrero Lopeno SE NE	DOQQ	1:12,000	Raster	1 m
L_228	TNRIS	USGS	So. of Potrero Lopeno SE NE	DOQQ	1:12,000	Raster	10 m
L_229	TNRIS	USGS	So. of Potrero Lopeno SE NE	DOQQ	1:12,000	Raster	30 m
L_230	TNRIS	USGS	So. of Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	1 m
L_231	TNRIS	USGS	So. of Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	10 m
L_232	TNRIS	USGS	So. of Potrero Lopeno SE NW	DOQQ	1:12,000	Raster	30 m
L_233	TNRIS	USGS	So. of Potrero Lopeno SE SE	DOQQ	1:12,000	Raster	1 m
L_234	TNRIS	USGS	So. of Potrero Lopeno SE SE	DOQQ	1:12,000	Raster	10 m
L_235	TNRIS	USGS	So. of Potrero Lopeno SE SE	DOQQ	1:12,000	Raster	30 m
L_236	TNRIS	USGS	So. of Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	1 m
L_237	TNRIS	USGS	So. of Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	10 m
L_238	TNRIS	USGS	So. of Potrero Lopeno SE SW	DOQQ	1:12,000	Raster	30 m
L_239	TNRIS	USGS	So. of Potrero Lopeno SE	DRG	1:24,000	Vector	
L_240	TNRIS	USGS	So. of Potrero Lopeno SE	DRG	1:100,000	Vector	
L_241	TNRIS	USGS	So. of Potrero Lopeno SE	DRG	1:250,000	Vector	

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_242	TNRIS	USGS	So. of Potrero Lopeno SE	Hypsography	1:24,000	Vector	
L_243	TNRIS	USGS	So. of Potrero Lopeno SE	DEM	1:24,000	Raster	30 m
L_244	TNRIS	USGS	Green Island NE	DOQQ	1:12,000	Raster	1 m
L_245	TNRIS	USGS	Green Island NE	DOQQ	1:12,000	Raster	10 m
L_246	TNRIS	USGS	Green Island NE	DOQQ	1:12,000	Raster	30 m
L_247	TNRIS	USGS	Green Island NW	DOQQ	1:12,000	Raster	1 m
L_248	TNRIS	USGS	Green Island NW	DOQQ	1:12,000	Raster	10 m
L_249	TNRIS	USGS	Green Island NW	DOQQ	1:12,000	Raster	30 m
L_250	TNRIS	USGS	Green Island SE	DOQQ	1:12,000	Raster	1 m
L_251	TNRIS	USGS	Green Island SE	DOQQ	1:12,000	Raster	10 m
L_252	TNRIS	USGS	Green Island SE	DOQQ	1:12,000	Raster	30 m
L_253	TNRIS	USGS	Green Island SW	DOQQ	1:12,000	Raster	1 m
L_254	TNRIS	USGS	Green Island SW	DOQQ	1:12,000	Raster	10 m
L_255	TNRIS	USGS	Green Island SW	DOQQ	1:12,000	Raster	30 m
L_256	TNRIS	USGS	Green Island	DRG	1:24,000	Vector	
L_257	TNRIS	USGS	Green Island	DRG	1:100,000	Vector	
L_258	TNRIS	USGS	Green Island	DRG	1:250,000	Vector	
L_259	TNRIS	USGS	Green Island	Hypsography	1:24,000	Vector	
L_260	TNRIS	USGS	Green Island	DEM	1:24,000	Raster	30 m
L_261	TNRIS	USGS	No. of Port Isabel NW NW	DOQQ	1:12,000	Raster	1 m
L_262	TNRIS	USGS	No. of Port Isabel NW NW	DOQQ	1:12,000	Raster	10 m
L_263	TNRIS	USGS	No. of Port Isabel NW NW	DOQQ	1:12,000	Raster	30 m
L_264	TNRIS	USGS	No. of Port Isabel NW SW	DOQQ	1:12,000	Raster	1 m
L_265	TNRIS	USGS	No. of Port Isabel NW SW	DOQQ	1:12,000	Raster	10 m
L_266	TNRIS	USGS	No. of Port Isabel NW SW	DOQQ	1:12,000	Raster	30 m
L_267	TNRIS	USGS	No. of Port Isabel NW	DRG	1:24,000	Vector	
L_268	TNRIS	USGS	No. of Port Isabel NW	DRG	1:100,000	Vector	
L_269	TNRIS	USGS	No. of Port Isabel NW	DRG	1:250,000	Vector	
L_270	TNRIS	USGS	No. of Port Isabel NW	Hypsography	1:24,000	Vector	
L_271	TNRIS	USGS	No. of Port Isabel NW	DEM	1:24,000	Raster	30 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_272	TNRIS	USGS	No. of Port Isabel SW NW	DOQQ	1:12,000	Raster	1 m
L_273	TNRIS	USGS	No. of Port Isabel SW NW	DOQQ	1:12,000	Raster	10 m
L_274	TNRIS	USGS	No. of Port Isabel SW NW	DOQQ	1:12,000	Raster	30 m
L_275	TNRIS	USGS	No. of Port Isabel SW SE	DOQQ	1:12,000	Raster	1 m
L_276	TNRIS	USGS	No. of Port Isabel SW SE	DOQQ	1:12,000	Raster	10 m
L_277	TNRIS	USGS	No. of Port Isabel SW SE	DOQQ	1:12,000	Raster	30 m
L_278	TNRIS	USGS	No. of Port Isabel SW SW	DOQQ	1:12,000	Raster	1 m
L_279	TNRIS	USGS	No. of Port Isabel SW SW	DOQQ	1:12,000	Raster	10 m
L_280	TNRIS	USGS	No. of Port Isabel SW SW	DOQQ	1:12,000	Raster	30 m
L_281	TNRIS	USGS	No. of Port Isabel SW	DRG	1:24,000	Vector	
L_282	TNRIS	USGS	No. of Port Isabel SW	DRG	1:100,000	Vector	
L_283	TNRIS	USGS	No. of Port Isabel SW	DRG	1:250,000	Vector	
L_284	TNRIS	USGS	No. of Port Isabel SW	Hypsography	1:24,000	Vector	
L_285	TNRIS	USGS	No. of Port Isabel SW	DEM	1:24,000	Raster	30 m
L_286	TNRIS	USGS	Three Islands NE	DOQQ	1:12,000	Raster	10 m
L_287	TNRIS	USGS	Three Islands NE	DOQQ	1:12,000	Raster	30 m
L_288	TNRIS	USGS	Three Islands NE	DOQQ	1:12,000	Raster	1 m
L_289	TNRIS	USGS	Three Islands NW	DOQQ	1:12,000	Raster	10 m
L_290	TNRIS	USGS	Three Islands NW	DOQQ	1:12,000	Raster	30 m
L_291	TNRIS	USGS	Three Islands NW	DOQQ	1:12,000	Raster	1 m
L_292	TNRIS	USGS	Three Islands SE	DOQQ	1:12,000	Raster	10 m
L_293	TNRIS	USGS	Three Islands SE	DOQQ	1:12,000	Raster	30 m
L_294	TNRIS	USGS	Three Islands SE	DOQQ	1:12,000	Raster	1 m
L_295	TNRIS	USGS	Three Islands SW	DOQQ	1:12,000	Raster	10 m
L_296	TNRIS	USGS	Three Islands SW	DOQQ	1:12,000	Raster	30 m
L_297	TNRIS	USGS	Three Islands SW	DOQQ	1:12,000	Raster	1 m
L_298	TNRIS	USGS	Three Islands	DRG	1:24,000	Vector	
L_299	TNRIS	USGS	Three Islands	DRG	1:100,000	Vector	
L_300	TNRIS	USGS	Three Islands	DRG	1:250,000	Vector	
L_301	TNRIS	USGS	Three Islands	Hypsography	1:24,000	Vector	

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_302	TNRIS	USGS	Three Islands	DEM	1:24,000	Raster	30 m
L_303	TNRIS	USGS	Port Isabel NW NE	DOQQ	1:12,000	Raster	1 m
L_304	TNRIS	USGS	Port Isabel NW NE	DOQQ	1:12,000	Raster	10 m
L_305	TNRIS	USGS	Port Isabel NW NE	DOQQ	1:12,000	Raster	30 m
L_306	TNRIS	USGS	Port Isabel NW NW	DOQQ	1:12,000	Raster	1 m
L_307	TNRIS	USGS	Port Isabel NW NW	DOQQ	1:12,000	Raster	10 m
L_308	TNRIS	USGS	Port Isabel NW NW	DOQQ	1:12,000	Raster	30 m
L_309	TNRIS	USGS	Port Isabel NW SE	DOQQ	1:12,000	Raster	1 m
L_310	TNRIS	USGS	Port Isabel NW SE	DOQQ	1:12,000	Raster	10 m
L_311	TNRIS	USGS	Port Isabel NW SE	DOQQ	1:12,000	Raster	30 m
L_312	TNRIS	USGS	Port Isabel NW SW	DOQQ	1:12,000	Raster	1 m
L_313	TNRIS	USGS	Port Isabel NW SW	DOQQ	1:12,000	Raster	10 m
L_314	TNRIS	USGS	Port Isabel NW SW	DOQQ	1:12,000	Raster	30 m
L_315	TNRIS	USGS	Port Isabel NW	DRG	1:24,000	Vector	
L_316	TNRIS	USGS	Port Isabel NW	DRG	1:100,000	Vector	
L_317	TNRIS	USGS	Port Isabel NW	DRG	1:250,000	Vector	
L_318	TNRIS	USGS	Port Isabel NW	Hypsography	1:24,000	Vector	
L_319	TNRIS	USGS	Port Isabel NW	DEM	1:24,000	Raster	30 m
L_320	TNRIS	USGS	Port Isabel NE	DOQQ	1:12,000	Raster	1 m
L_321	TNRIS	USGS	Port Isabel NE	DOQQ	1:12,000	Raster	10 m
L_322	TNRIS	USGS	Port Isabel NE	DOQQ	1:12,000	Raster	30 m
L_323	TNRIS	USGS	Port Isabel NW	DOQQ	1:12,000	Raster	1 m
L_324	TNRIS	USGS	Port Isabel NW	DOQQ	1:12,000	Raster	10 m
L_325	TNRIS	USGS	Port Isabel NW	DOQQ	1:12,000	Raster	30 m
L_326	TNRIS	USGS	Port Isabel SE	DOQQ	1:12,000	Raster	1 m
L_327	TNRIS	USGS	Port Isabel SE	DOQQ	1:12,000	Raster	10 m
L_328	TNRIS	USGS	Port Isabel SE	DOQQ	1:12,000	Raster	30 m
L_329	TNRIS	USGS	Port Isabel SW	DOQQ	1:12,000	Raster	1 m
L_330	TNRIS	USGS	Port Isabel SW	DOQQ	1:12,000	Raster	10 m
L_331	TNRIS	USGS	Port Isabel SW	DOQQ	1:12,000	Raster	30 m

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_332	TNRIS	USGS	Port Isabel	DRG	1:24,000	Vector	
L_333	TNRIS	USGS	Port Isabel	DRG	1:100,000	Vector	
L_334	TNRIS	USGS	Port Isabel	DRG	1:250,000	Vector	
L_335	TNRIS	USGS	Port Isabel	Hypsography	1:24,000	Vector	
L_336	TNRIS	USGS	Port Isabel	DEM	1:24,000	Raster	30 m
L_337	TNRIS		Aransas County	DOQ Mosaic	1:12,000	Raster	1 m
L_338	TNRIS		Cameron County	DOQ Mosaic	1:12,000	Raster	1 m
L_339	TNRIS		Kenedy County	DOQ Mosaic	1:12,000	Raster	1 m
L_340	TNRIS		Kleberg County	DOQ Mosaic	1:12,000	Raster	1 m
L_341	TNRIS		Nueces County	DOQ Mosaic	1:12,000	Raster	1 m
L_342	TNRIS		San Patricio County	DOQ Mosaic	1:12,000	Raster	1 m
L_343	TNRIS		Willacy County	DOQ Mosaic	1:12,000	Raster	1 m
L_344	TNRIS	TWDB	Baffin Bay Degree Block (28N 27S 98W 97E)	Hillshade		Vector	
L_345	TNRIS	TWDB	Corpus Christi Degree Block (28N 27S 98W 97E)	Hillshade		Vector	
L_346	TNRIS	TWDB	Harlingen Degree Block (27N 26S 98W 97E)	Hillshade		Vector	
L_347	TNRIS	TWDB	Port Mansfield Degree Block (27N 26S 98W 97E)	Hillshade		Vector	
L_348	TNRIS		Baffin Bay Degree Block (28N 27S 98W 97E)	NED			
L_349	TNRIS		Corpus Christi Degree Block (28N 27S 98W 97E)	NED			
L_350	TNRIS		Harlingen Degree Block (27N 26S 98W 97E)	NED			
L_351	TNRIS		Port Mansfield Degree Block (27N 26S 98W 97E)	NED			
L_352	USGS	USGS	Baffin Bay Watershed	NHD	1:100,000	Vector	
L_353	USGS	USGS	Central Laguna Madre Watershed	NHD	1:100,000	Vector	
L_354	USGS	USGS	North Laguna Madre Watershed	NHD	1:100,000	Vector	
L_355	USGS	USGS	South Corpus Christi Bay Watershed	NHD	1:100,000	Vector	
L_356	USGS	USGS	South Laguna Madre Watershed	NHD	1:100,000	Vector	
L_357	RRC	RRC	Aransas County	Pipeline and Well			
L_358	RRC	RRC	Cameron County	Pipeline and Well			
L_359	RRC	RRC	Kenedy County	Pipeline and Well			
L_360	RRC	RRC	Kleberg County	Pipeline and Well			
L_361	RRC	RRC	Nueces County	Pipeline and Well			
L_362	RRC	RRC	San Patricio County	Pipeline and Well			

Park Specific (Local): by Quarter-Quad, Quad, County or Watershed

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
L_363	RRC	RRC	Willacy County	Pipeline and Well			
L_364	TNRIS/NRCS	NRCS	Aransas County	Soil	1:24,000	Vector	1 m
L_365	TNRIS/NRCS	NRCS	Cameron County	Soil	1:24,000	Vector	1 m
L_366	TNRIS/NRCS	NRCS	Nueces County	Soil	1:24,000	Vector	1 m
L_367	TNRIS/NRCS	NRCS	Willacy County	Soil	1:24,000	Vector	1 m
L_368	TNRIS	TxDOT	Aransas County	Transportation Urban		Vector	
L_369	TNRIS	TxDOT	Cameron County	Transportation Urban		Vector	
L_370	TNRIS	TxDOT	Kenedy County	Transportation Urban		Vector	
L_371	TNRIS	TxDOT	Kleberg County	Transportation Urban		Vector	
L_372	TNRIS	TxDOT	Nueces County	Transportation Urban		Vector	
L_373	TNRIS	TxDOT	San Patricio County	Transportation Urban		Vector	
L_374	TNRIS	TxDOT	Willacy County	Transportation Urban		Vector	

Texas Coast						
ID	Available From	Originator/Publisher	Location	Data	Scale	Structure
C_1	BEG	BEG	State Coast_Upper	Historical Shoreline Data		vector
C_2	BEG	BEG	State Coast_Central and Lower	Historical Shoreline Data		vector
C_3	BEG	BEG	State Coast_Sabine Pass to Brazos River	Projected Shoreline Data		Vector
C_4	BEG	BEG	State Coast_Sabine Pass to Brazos River	Projected Shoreline Data		Vector
C_5	BEG	BEG	State Coast_Sabine Pass to Brazos River	Projected Shoreline Data		Vector
C_6	BEG	BEG	State Coast_Brazos River to Pass Cavallo	Projected Shoreline Data		Vector
C_7	BEG	BEG	State Coast_Aransas Pass to PAIS (Mustang and North Padre Islands)	Projected Shoreline Data		Vector
C_8	BEG	BEG	State Coast_Baffin Bay	Projected Shoreline Data		Vector
C_9	BEG	BEG	State Coast_Sabine Pass to Brazos River	Shoreline Change Rates		Vector
C_10	BEG	BEG	State Coast_Brazos River to Pass Cavallo	Shoreline Change Rates		Vector
C_11	BEG	BEG	State Coast_Aransas Pass to PAIS (Mustang and North Padre Islands)	Shoreline Change Rates		Vector
C_12	BEG	BEG	State Coast_South Padre Island	Shoreline Change Rates		Vector
C_13	BEG	BEG	State Coast_Baffin Bay	Shoreline Change Rates		Vector
C_14	BEG	BEG	State Coast_West Bay	Shoreline Change Rates		Vector
C_15	BEG	BEG	State Coast_Sabine Pass to Matagorda Peninsula	Shoreline Types		Vector
C_16	BEG	BEG	State Coast_Matagorda Peninsula to Rio Grande	Shoreline Types		Vector
C_17	TGLO	TCCC	Coastal Management Program Boundary	Archeological Sites	1:24,000	Vector
C_18	TGLO	USFW/TGLO	State Coast	Coastal Barrier Resource System	1:24,000	Vector
C_19	TGLO	CCC	Coastal Management Program Boundary	Coastal Management Zone Boundary	1:24,000	Vector
C_20	TGLO	TGLO	State Coast	Critical Erosion Areas	1:24,000	Vector
C_21	TGLO	TGLO	State Coast	Dredged Material Placement Sites		Vector
C_22	TGLO	TGLO	State Coast	Dune Protection Lines	1:24,000	Vector
C_23	TGLO	CCC	Baffin Bay/Laguna Madre	Hard Substrate Reefs (Baffin Bay/Laguna Madre)	1:40,000	Vector
C_24	TGLO	LOSCO	State Coast	In-Situ Burn Exclusion Areas		Vector
C_25	TGLO	TPWD	State Coast (Corpus Christi Bay Area)	Land Use/Land Cover (Corpus Christi Bay Area)		Raster
C_26	TGLO	TPWD	State Coast (Galveston Bay Area)	Land Use/Land Cover (Galveston Bay Area)		Raster

Texas Coast						
ID	Available From	Originator/Publisher	Location	Data	Scale	Structure
C_27	TGLO	TPWD	State Coast (Lower Coast)	Land Use/Land Cover (Lower Coast)		Raster
C_28	TGLO	TPWD	State Coast (Sabine Lake Area)	Land Use/Land Cover (Sabine Lake Area)		Raster
C_29	TGLO	TGLO	State Coast	Marinas	1:24,000	Vector
C_30	TGLO	TGLO	State Coast	National Marine Sanctuary	1:24,000	Vector
C_31	TGLO	CCC	Coastal Management Program Boundary	National Register of Historic Places	1:24,000	Vector
C_32	TGLO	USFW/TGLO	State Coastal Counties	National Wetlands Inventory Data	1:24,000	Vector
C_33	TGLO			Navigation Districts		Vector
C_34	TGLO	USMMS	Gulf Coast (Western)	Offshore Lease Blocks		Vector
C_35	TGLO	LOSCO	Gulf Coast	Offshore Oil/Gas Platforms		Vector
C_36	TGLO	TGLO	State Coast	Oil and Gas Lease Sale Nominations		Vector
C_37	TGLO	TGLO	State Coast	Oil and Gas Leases		Vector
C_38	TGLO	TGLO	State Coast	Oil and Gas Pooling Agreements/Units		Vector
C_39	TGLO	TGLO	Galveston Bay System	Oyster Reefs (Galveston Bay System)	1:24,000	Vector
C_40	TGLO	TPWD	San Antonio Bay System	Oyster Reefs (San Antonio Bay System)		Vector
C_41	TGLO	TGLO/TPWD	Gulf Coast (Lower)	Priority Protection Habitat Areas (Lower Coast)	1:24,000	Vector
C_42	TGLO	TGLO/TPWD	Gulf Coast (Upper)	Priority Protection Habitat Areas (Upper Coast)	1:24,000	Vector
C_43	TGLO			Private Oyster Leases		Vector
C_44	TGLO	TGLO/TxDOT	State Coastal Counties (Central)	Roads/Highways (Central Coast)	1:24,000	Vector
C_45	TGLO	TGLO/TxDOT	State Coastal Counties (Lower)	Roads/Highways (Lower Coast)	1:24,000	Vector
C_46	TGLO	TGLO/TxDOT	State Coastal Counties (Upper)	Roads/Highways (Upper Coast)	1:24,000	Vector
C_47	TGLO	TPWD	Corpus Christi Bay System, San Antonio Bay System, Aransas Bay System	Seagrass Areas	1:24,000	Vector
C_48	TGLO	USACE/TGLO	Gulf Coast (Western)	Shipping Safety Fairways		Vector
C_49	TGLO	TGLO/TPWD	State Coast	Species/Habitats	1:24,000	Vector
C_50	TGLO	TGLO	State Coast	State Coastal Preserves	1:24,000	Vector
C_51	TGLO	TGLO	State Coast	State Tracts with Resource Management Codes		Vector
C_52	TGLO		Gulf Coast	Three Nautical Mile Line		Vector
C_53	TGLO	TGLO	State Coastal Counties	US Coast Guard Stations	1:24,000	Vector
C_54	TGLO	BEG	State Coast	Washover Areas	1:24,000	Vector
C_55	TGLO	CCC	State Coast	Waters of the Open Gulf of Mexico	1:24,000	Vector
C_56	TGLO	CCC	State Coast	Waters Under Tidal Influence		Vector
C_57	TGLO (NRI)	GERG	State Coast	Aliphatics (Current)		Vector
C_58	TGLO (NRI)	GERG	State Coast	Aliphatics (Historical)		Vector

Texas Coast

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure
C_59	TGLO (NRI)	GERG	State Coast	Aromatics (Current)		Vector
C_60	TGLO (NRI)	GERG	State Coast (except Sabine Lake)	Aromatics (Historical)		Vector
C_61	TGLO (NRI)	TPWD	State Coast	Bag Seine Sample Locations		Vector
C_62	TGLO (NRI)	TPWD	State Coast	Beach Seine Sample Locations		Vector
C_63	TGLO (NRI)	TPWD	State Coast	Boat Ramps	1:40,000	Vector
C_64	TGLO (NRI)	TPWD	State Coast	Gill Net Sample Locations		Vector
C_65	TGLO (NRI)	GERG	State Coast	Grain Sizes (Current)		Vector
C_66	TGLO (NRI)	TGLO	State Coast	Gulf Beach Access Points		Vector
C_67	TGLO (NRI)	RRC	State Coastal Counties	Horizontal/Directional Wells	1:24,000	Vector
C_68	TGLO (NRI)	TGLO	State Coast (incomplete)	Marinas		Vector
C_69	TGLO (NRI)	GERG	State Coast (except Sabine Lake)	Pesticides (Current)		Vector
C_70	TGLO (NRI)	GERG	State Coast	Pesticides (Historical)		Vector
C_71	TGLO (NRI)	TPWD	State Coast	Recreational Fishing Survey Sample Locations (Ramp)	1:24,000 (exceptions: Matagorda=1:80,000 Sabine=1:12,000)	Vector
C_72	TGLO (NRI)	TPWD	State Coast	Recreational Fishing Survey Sample Locations (Roving Boat)	1:24,000 (exceptions: Matagorda=1:80,000 Sabine=1:12,000)	Vector
C_73	TGLO (NRI)	BEG	State Coast	Sediment Sampling		Vector
C_74	TGLO (NRI)	TGLO	State Coastal Counties	State Parks and Wildlife Management Areas		Vector
C_75	TGLO (NRI)	RRC	State Coastal Counties	Surface Locations	1:24,000	Vector
C_76	TGLO (NRI)	GERG	State Coast (except Sabine Lake)	Trace Metals (Historical)		Vector
C_77	TGLO (NRI)	TPWD	State Coast	Trawl Sample Locations		Vector
C_78	TGLO (NRI)	RRC	State Coastal Counties	Vertical Wells	1:24,000	Vector
C_79	TGLO (NRI)	BEG	State Coast	Washover Areas	1:24,000	Vector

Texas State-Wide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
S_1	BEG	BEG	State	Oil and Gas Reservoirs		Vector	
S_2	FEMA	FEMA	State	Q3 Flood Data			
S_3	NRCS		State	Precipitation			
S_4	TCEQ		State	Designated Stream Segments		Vector	
S_5	TCEQ		State	Stream Segment Boundaries		Vector	
S_6	TGLO	USACE/TGLO	State	Anchorage Areas		Vector	
S_7	TGLO	TGLO	State	Aquaculture Facilities	1:24,000	Vector	
S_8	TGLO	TGLO	State	Audubon Sanctuaries		Vector	
S_9	TGLO	NOAA/TGLA	State	Bathymetry		Vector	
S_10	TGLO	NOAA/TGLA	State	Bathymetry (6-foot depth)		Vector	
S_11	TGLO	TGLO	State	Beach Access	1:24,000	Vector	
S_12	TGLO	TPWD	State	Boat Ramps	1:24,000	Vector	
S_13	TGLO	TGLO	State	Cabins	1:24,000	Vector	
S_14	TGLO	TxDOT	State	City and County Parks	1:24,000	Vector	
S_15	TGLO	TxDOT	State	City Limits		Vector	
S_16	TGLO	TGLO	State	Coastal Leases	1:24,000	Vector	
S_17	TGLO	TGLO/TPWD	State	Colonial Waterbird Rookery Areas	1:24,000	Vector	
S_18	TGLO	TNRCC	State	County Boundaries	1:24,000	Vector	
S_19	TGLO		State	Dispersant Use Pre-Approval Zone		Vector	
S_20	TGLO	USGS, TGLO	State	Elevation	1:250,000	Vector	
S_21	TGLO	TGLO/BEG	State	Environmental Sensitivity Index Shoreline		Vector	
S_22	TGLO	USACE/TGLO	State	Gulf Intracoastal Waterway/Ship Channels	1:24,000	Vector	
S_23	TGLO	TxDOT/TGLO	State	Heliports	1:24,000	Vector	
S_24	TGLO		State	Hydrography (coastal)	1:24,000	Vector	
S_25	TGLO	TxDOT/TGLO	State	Hydrography (detailed)	1:24,000	Vector	
S_26	TGLO	TxDOT	State	Hydrography (general)	1:24,000	Vector	
S_27	TGLO	USGS	State	Hydrography (general)	1:2,000,000	Vector	
S_28	TGLO	TGLO	State	National Wildlife Refuges	1:24,000	Vector	
S_29	TGLO	TPWD	State	Natural Regions (major)		Vector	
S_30	TGLO	TPWD	State	Natural Regions (sub)		Vector	
S_31	TGLO		State	Oil and Gas Pipelines		Vector	
S_32	TGLO	TGLO	State	Place Names	1:750,000	Vector	
S_33	TGLO	USGS/TGLO	State	Place Names	1:24,000	Vector	

Texas State-Wide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
S_34	TGLO	TGLO	State	Place Names (populated)		Vector	
S_35	TGLO	TxDOT	State	Railroads	1:24,000	Vector	
S_36	TGLO	TWDB	State	Rainfall			
S_37	TGLO	USDOT	State	Roads/Highways	1:24,000	Vector	
S_38	TGLO	NOAA/NOS/NGS	State	Shoreline	variable (source scale is listed in attribute table of features)	Vector	
S_39	TGLO	TPWD	State	State Parks/Wildlife Management Areas	1:24,000	Vector	
S_40	TGLO	TGLO	State	Submerged Lands		Vector	
S_41	TGLO	USGS/TGLO	State	Topography	1:250,000	Raster	5000 ft
S_42	TGLO	TGLO	State	Urban Areas	1:24,000	Vector	
S_43	TGLO	TPWD	State	Vegetation Areas		Vector	
S_44	TGLO (NRI)	TNRCC	State	Air Monitoring Stations	1:24,000/1:100,000	Vector	
S_45	TGLO (NRI)	RRC	State	Tidal Disposal Facilities		Vector	
S_46	TGLO (NRI)	TNRCC	State estuaries and tidal tributaries	Water and Sediment Quality Sample Locations		Vector	
S_47	TNRCC	TCEQ	State	Surface Water Rights Diversion Points		Vector	
S_48	TNRIS	USGS	State	Active Mines and Mineral Plants			
S_49	TNRIS	TCEQ	State	Air Monitoring Sites		Vector	
S_50	TNRIS	TCEQ	State	Air Quality Nonattainment and Near Nonattainment Areas		Vector	
S_51	TNRIS		State	Airports		Vector	
S_52	TNRIS		State	Cities			
S_53	TNRIS		State	County Boundaries	1:250,000		
S_54	TNRIS		State	County Boundaries (with 15 League Limit)			
S_55	TNRIS		State	County Boundaries (with coastline)	1:24,000		
S_56	TNRIS		State	County Boundaries (with generalized coastline)	1:24,000		
S_57	TNRIS		State	Highways		Vector	
S_58	TNRIS	TCEQ	State	Industrial and Hazardous Waste Sites		Vector	
S_59	TNRIS		State	Land Use/Land Cover		Vector	
S_60	TNRIS	TCEQ	State	Landfills		Vector	
S_61	TNRIS	USGS	State	Mineral Availability System			

Texas State-Wide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
S_62	TNRIS	USGS	State	Mineral Resource Data			
S_63	TNRIS		State	National Parks			
S_64	TNRIS	TPWD	State	Natural Regions (major)		Vector	
S_65	TNRIS	TPWD	State	Natural Regions (sub)		Vector	
S_66	TNRIS		State	Precipitation			
S_67	TNRIS	TCEQ	State	Public Water Supply Sources		Vector	
S_68	TNRIS		State	Quads (1 degree blocks)		Vector	
S_69	TNRIS		State	Quads (1:100,000)		Vector	
S_70	TNRIS		State	Quads (1:12,000; 3.75 minute)		Vector	
S_71	TNRIS		State	Quads (1:24,000; 7.5 minute)		Vector	
S_72	TNRIS	TCEQ	State	Radioactive Waste Sites		Vector	
S_73	TNRIS		State	Railroads		Vector	
S_74	TNRIS		State	Reservoirs		Vector	
S_75	TNRIS	TLC	State	School District Boundaries			
S_76	TNRIS		State	State Parks			
S_77	TNRIS		State	STATSGO (soils)			
S_78	TNRIS		State	Streams		Vector	
S_79	TNRIS	TCEQ	State	Superfund Sites		Vector	
S_80	TNRIS	TCEQ	State	TCEQ Regions			
S_81	TNRIS	TLC	State	Texas House Districts			
S_82	TNRIS		State	Urban Areas			
S_83	TNRIS	TPWD	State	Vegetation Types		Vector	
S_84	TNRIS		State	zip codes			
S_85	TWDB		State	Basins		Raster	
S_86	TWDB		State	Economically Distressed Areas			
S_87	TWDB	TWDB	State	Existing Conveyances		Vector	
S_88	TWDB	BEG	State	Existing Reservoirs		Vector	
S_89	TWDB	not available	State	Groundwater Conservation Districts		Vector	
S_90	TWDB	not available	State	Groundwater Management Areas		Vector	
S_91	TWDB	TWDB	State	Hillshade		Raster	
S_92	TWDB	USGS	State	Hydraulic Unit Code (HUC)	1:500,000	Vector	
S_93	TWDB	TWDB	State	Major Aquifers	1:250,000	Vector	
S_94	TWDB	USGS	State	Major Rivers	1:2,000,000	Vector	

Texas State-Wide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
S_95	TWDB	TWDB	State	Minor Aquifers	1:250,000	Vector	
S_96	TWDB	not available	State	OPFCA Regions and Field Office		Vector	
S_97	TWDB	TWDB	State	Priority Groundwater Management Areas		Vector	
S_98	TWDB	TWDB	State	Proposed Conveyances		Vector	
S_99	TWDB	BEG	State	Recommended Reservoirs		Vector	
S_100	TWDB	TWDB	State	Regional Water Planning Areas		Vector	
S_101	TWDB	not available	State	River Authorities and Special Law Districts	1:100,000 (rivers), 1:500,000 (basins)	Vector	
S_102	TWDB	USGS	State	River Basins	1:500,000	Vector	
S_103	TWDB	not available	State	StratMap County Boundaries with Coastline	1:24,000	Vector	
S_104	TWDB	not available	State	StratMap County Boundaries without Coastline	1:24,000	Vector	
S_105	TWDB	not available	State	StratMap Municipality Boundaries	1:24,000	Vector	
S_106	TWDB	not available	State	StratMap Texas State Boundary with Coastline	1:24,000	Vector	
S_107	TWDB	not available	State	StratMap Texas State Boundary without Coastline	1:24,000	Vector	
S_108	TWDB	TWDB	State	Submitted Drillers Report Database		Vector	
S_109	TWDB	TWDB	State	Terrain		Raster	
S_110	TWDB	Texas Legislative Council	State	Texas House Districts (2002)		Vector	
S_111	TWDB	Chris Daly & George Taylor	State	Texas Precipitation		Vector	
S_112	TWDB	Texas Legislative Council	State	Texas Senate Districts (2002)		Vector	
S_113	TWDB	TWDB	State	TWDB Groundwater Database Welldata		Vector	
S_114	TWDB	TWDB	State	Well Location Grid			
S_115	USEPA	USGS	State-Southeast	Multi-Resolution Land Characteristics Consortium (National Land Cover Data)		Raster	30 m
S_116	USFS	USFS	State-Southeast	LAA - Forest Area Connectivity		Raster	30 m
S_117	USFS	USFS	State-Southeast	LAA - Forest Area Density		Raster	30 m
S_118	USFS	USFS	State-Southeast	LAA - Forest Fragmentation Index		Raster	30 m
S_119	USFS	USFS	State-Southeast	LAA - Human Use Index		Raster	30 m
S_120	USFS	USFS	State-Southeast	LAA - Land Cover Contagion		Raster	30 m
S_121	USFS	USFS	State-Southeast	LAA - Land Cover Diversity		Raster	30 m
S_122	USFS	USFS	State-Southeast	LAA - Landscape Pattern Type Index A		Raster	30 m

Texas State-Wide							
ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
S_123	USGS	USGS	State	GAP Analysis Project			

Nationwide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
	http://mrdata.usgs.gov/sddpftp.html						
N_1	USGS	USGS	Nationwide	Igneous rocks PLUTO		Vector	
N_2	USGS	USGS	Nationwide	NURE Sediment Chemistry		Raster	
N_3	USGS	USGS	Nationwide	Soil Chemistry		Vector	
N_4	USGS	USGS	Nationwide	Soils PLUTO		Vector	
N_5	USGS	USGS	Nationwide	Soils RASS		Vector	
N_6	USGS	USGS	Nationwide	Unconsolidated Sediments PLUTO		Vector	
N_7	USGS	USGS	Nationwide	Unconsolidated Sediments RASS		Vector	
N_8	USGS	USGS	Nationwide	US Geology	1:2,500,000	Raster	1000 m
N_9	USGS	USGS	Nationwide	US Geology [Geologic Faults]	1:2,500,000	Raster	1000 m
N_10	USGS	USGS	Nationwide	US Aeromagnetics		Raster	1000 m
N_11	USGS	USGS	Nationwide	US Bouguer Gravity Field		Raster	4 km
N_12	USGS	USGS	Nationwide	US Isostatic Gravity Field		Raster	4 km
N_13	USGS	USGS	Nationwide	US Magnetism NW Illumination		Raster	2 km
N_14	USGS	USGS	Nationwide	Active Mines and Mineral Plants		Vector	
N_15	USGS	USGS	Nationwide	Mineral Availability System		Vector	
N_16	USGS	USGS	Nationwide	Mineral Resource Data		Vector	
N_17	TNRIS		Nationwide	USA Boundary			
N_18	TGLO	NPS, WRD	Nationwide	National Parks	1:24,000	Vector	
N_19	USGS	USGS	Nationwide	Cities	1:2,000,000	Vector	
N_20	USGS	USGS	Nationwide	Counties		Vector	
N_21	USGS	USGS	Nationwide	Elevated Shaded Relief		Raster	2km
N_22	USGS	USGS	Nationwide	Federal Lands	1:2,000,000	Vector	
N_23	USGS	USGS	Nationwide	Hydrologic Units	1:250,000 and 1:100,000	Vector	
N_24	USGS	USGS	Nationwide	Hydrology	1:2,000,000	Vector	
N_25	USGS	USGS	Nationwide	Land Cover		Raster	1000 m
N_26	USGS	USGS	Nationwide	Railroads	1:100,000	Vector	
N_27	USGS	USGS	Nationwide	Roads	1:3,000,000	Vector	
N_28	USGS	USGS	Nationwide	Urban Areas		Vector	
N_29	USGS	USGS	Nationwide	USA	1:25,000,000	Vector	
N_30	USGS	USGS	Nationwide	24000 Quadrangle Boundaries		Vector	

Nationwide

ID	Available From	Originator/Publisher	Location	Data	Scale	Structure	Resolution
N_31	USGS	USGS	Nationwide	250000 Quadrangle LU/LC	1:250,000	Vector	
www.epa.gov/mrlc/data.html (links to spatial and non-spatial data, nationwide)							
N_32	USFS	USFS	13 state region (including TX, LA, MS)	LAA - Assessment Projects by watershed		Vector	
N_33	USFS	USFS	13 state region (including TX, LA, MS)	LAA - Assessment Projects by county		Vector	
N_34	USFS	USFS	13 state region (including TX, LA, MS)	LAA - Assessment Projects by ecoregion		Vector	
N_35	USGS	USGS	Nationwide	Geology of the US			
N_36	NRCS/USDA	NRCS/USDA	Nationwide	Tiger 2002 Road			
N_37	NRCS/USDA	NRCS/USDA	Nationwide	Tiger 2002 Railroad			
N_38	NRCS/USDA	NRCS/USDA	Nationwide	Tiger 2002 hydrography			
N_39	NRCS/USDA	NRCS/USDA	Nationwide	Tiger 2000 water			
N_40	NRCS/USDA	NRCS/USDA	Nationwide	FEMAQ3 Flood Data	1:24,000		
N_41	NRCS/USDA	NRCS/USDA	Nationwide	8-digit hydrologic units	1:250,000		
N_42	NRCS/USDA	NRCS/USDA	Nationwide	DRG County Mosaic			
N_43	NRCS/USDA	NRCS/USDA	Nationwide	DRG	1:24,000		
N_44	NRCS/USDA	NRCS/USDA	Nationwide	DRG	1:100,000		
N_45	NRCS/USDA	NRCS/USDA	Nationwide	DRG	1:250,000		
N_46	NRCS/USDA	NRCS/USDA	Nationwide	Quad 1:24,000 map index			
N_47	NRCS/USDA	NRCS/USDA	Nationwide	Quad 1:100,000 map index			
N_48	NRCS/USDA	NRCS/USDA	Nationwide	Quad 1:250,000 map index			
N_49	NRCS/USDA	NRCS/USDA	Nationwide	Quad 1 degree by state map index			
N_50	NRCS/USDA	NRCS/USDA	Nationwide	National Elevation Dataset			
N_51	NRCS/USDA	NRCS/USDA	Nationwide	DEM			
N_52	NRCS/USDA	NRCS/USDA	Nationwide	DOQ County Mosaic by APFO			
N_53	NRCS/USDA	NRCS/USDA	Nationwide	ErMapper Ortho Mosaic by NRCS			
N_54	NRCS/USDA	NRCS/USDA	Nationwide	National Land Cover Dataset by State			
N_55	NRCS/USDA	NRCS/USDA	Nationwide	Soil Survey Geographic (SSURGO) data base			
N_56	NRCS/USDA	NRCS/USDA	Nationwide	Annual Average Precipitation by state			
N_57	NRCS/USDA	NRCS/USDA	Nationwide	Monthly Average Precipitation by state			

Nationwide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
	http://nationalatlas.gov/atlasftp.html						
N_58	NationalAtlas	USDA/NRCS	Nationwide	Average Annual Precipitation	1:2,000,000	vector	
N_59	NationalAtlas	USGS	Nationwide	Breeding Bird Survey Routes	1:2,000,000	vector	
N_60	NationalAtlas	USGS	Nationwide	County Boundaries	1:2,000,000	vector	
N_61	NationalAtlas	USACE	Nationwide	Dams	1:2,000,000	vector	
N_62	NationalAtlas	USFS	Nationwide	Ecoregions	1:2,000,000	vector	
N_63	NationalAtlas	USFS/USGS	Nationwide	Forest Cover Types	1:2,000,000	raster	
N_64	NationalAtlas	USGS	Nationwide	Forest Fragmentation Classification	1:2,000,000	raster	
N_65	NationalAtlas	USEPA/USGS	Nationwide	Forest Fragmentation Causes	1:2,000,000	raster	1 km
N_66	NationalAtlas	USEPA	Nationwide	Forest Fragmentation Causes	1:2,000,000	raster	540 m
N_67	NationalAtlas	USEPA	Nationwide	Forest Fragmentation Causes	1:2,000,000	raster	270 m
N_68	NationalAtlas	USGS	Nationwide	Generalized Geologic Map	1:2,000,000	vector	
N_69	NationalAtlas	USGS	Nationwide	Hydrologic Unit Boundaries	1:2,000,000	vector	
N_70	NationalAtlas	USGS	Nationwide	Invasive Species_Zebra Mussels	1:2,000,000	vector	
N_71	NationalAtlas	USGS	Nationwide	Land Cover Characteristics	1:2,000,000	raster	
N_72	NationalAtlas	USGS	Nationwide	Land Cover Diversity	1:2,000,000	raster	
N_73	NationalAtlas	USGS	Nationwide	Mineral Operations_Agriculture	1:2,000,000	vector	
N_74	NationalAtlas	USGS	Nationwide	Mineral Operations_Construction	1:2,000,000	vector	
N_75	NationalAtlas	USGS	Nationwide	Mineral Operations_Ferrous Metal Mines	1:2,000,000	vector	
N_76	NationalAtlas	USGS	Nationwide	Mineral Operations_Ferrous Metals Processing Plants	1:2,000,000	vector	
N_77	NationalAtlas	USGS	Nationwide	Mineral Operations_Miscellaneous Industrial	1:2,000,000	vector	
N_78	NationalAtlas	USGS	Nationwide	Mineral Operations_Nonferrous Metal Mines	1:2,000,000	vector	
N_79	NationalAtlas	USGS	Nationwide	Mineral Operations_Nonferrous Metal Processing Plants	1:2,000,000	vector	
N_80	NationalAtlas	USGS	Nationwide	Mineral Operations_Refractory, Abrasive, and other Industrial	1:2,000,000	vector	
N_81	NationalAtlas	USGS	Nationwide	Mineral Operations_Sand and Gravel	1:2,000,000	vector	
N_82	NationalAtlas	USGS	Nationwide	Mineral Operations_Stone, Crushed	1:2,000,000	vector	
N_83	NationalAtlas	USGS	Nationwide	NAWQA Surface-Water Sampling Sites	1:2,000,000	vector	
N_84	NationalAtlas	USGS	Nationwide	North American Bat Ranges	1:2,000,000	vector	
N_85	NationalAtlas	USGS	Nationwide	Parkways and Scenic Rivers	1:2,000,000	vector	
N_86	NationalAtlas	USGS	Nationwide	Principal Aquifers	1:2,000,000	vector	
N_87	NationalAtlas	USGS	Nationwide	Public Land Survey	1:2,000,000	vector	
N_88	NationalAtlas	USGS	Nationwide	Railroads	1:2,000,000	vector	

Nationwide

ID	Available From	Originator/ Publisher	Location	Data	Scale	Structure	Resolution
N_89	NationalAtlas	USGS	Nationwide	Realtime Streamflow Stations	1:2,000,000	vector	
N_90	NationalAtlas	USGS	Nationwide	Roads	1:2,000,000	vector	
N_91	NationalAtlas	USGS	Nationwide	Shaded Relief of North America	1:2,000,000	raster	
N_92	NationalAtlas	USGS	Nationwide	States	1:2,000,000	vector	
N_93	NationalAtlas	USGS	Nationwide	Streams and Waterbodies	1:2,000,000	vector	
N_94	NationalAtlas	USGS	Nationwide	Wilderness Areas	1:2,000,000	vector	
N_95	NationalAtlas	USGS	Nationwide	Amphibian Distributions			
N_96	NationalAtlas	USGS	Nationwide	Butterflies			
N_97	NationalAtlas	USDA/NRCS	Nationwide	Invasive Species_Chinese Privet			
N_98	NationalAtlas	USDA/NRCS	Nationwide	Invasive Species_Tallowtree			
N_99	NationalAtlas	USDA/NRCS	Nationwide	Invasive Species_Common Gorse			
N_100	NationalAtlas	USDA/NRCS	Nationwide	Invasive Species_Leafy Spurge			
N_101	NationalAtlas	USDA/NRCS	Nationwide	Invasive Species_Purple Loosestrife			
N_102	NationalAtlas	USGS	Nationwide	Moths			
N_103	NationalAtlas	CDC	Nationwide	West Niles Virus_Human Cases			
N_104	NationalAtlas	CDC	Nationwide	West Niles Virus_Mosquito Surveillance			
N_105	NationalAtlas	CDC	Nationwide	West Niles Virus_Sentinel Flock Surveillance			
N_106	NationalAtlas	CDC	Nationwide	West Niles Virus_Veterinary Cases			
N_107	NationalAtlas	CDC	Nationwide	West Niles Virus_Wild Bird Cases			
N_108	NationalAtlas	CDC	Nationwide	West Niles Virus_Human Cases			
N_109	NationalAtlas	CDC	Nationwide	West Niles Virus_Mosquito Surveillance			
N_110	NationalAtlas	CDC	Nationwide	West Niles Virus_Sentinel Flock Surveillance			
N_111	NationalAtlas	CDC	Nationwide	West Niles Virus_Veterinary Cases			
N_112	NationalAtlas	CDC	Nationwide	West Niles Virus_Wild Bird Cases			
N_113	NationalAtlas	USGS NWHC	Nationwide	Wildlife Mortality_Frequency Data			
N_114	NationalAtlas	USGS NWHC	Nationwide	Wildlife Mortality_Botulism			
N_115	NationalAtlas	USGS NWHC	Nationwide	Wildlife Mortality_Cholera			
N_116	NationalAtlas	USGS NWHC	Nationwide	Wildlife Mortality_Lead Poisoning			
N_117	NationalAtlas	USGS NWHC	Nationwide	Wildlife Mortality_OP/CARB Poisoning			

NonGIS Digital Maps

ID	Available From	Originator/ Publisher	Location	Map	Scale
M_1	TGLO (NRI)	CCC	Corpus Christi	Corpus Christi Area (Coastal Zone Boundary)	
M_2	TGLO (NRI)	CCC	Kingsville	Kingsville Area (Coastal Zone Boundary)	
M_3	TGLO (NRI)	CCC	Brownsville-Harlingen	Brownsville-Harlingen Area (Coastal Zone Boundary)	
M_4	TGLO	TGLO	Galveston Island Unit TX-05P	Coastal Barrier Resource System Maps	1:24,000
M_5	TGLO	TGLO	Brazos River Complex T05/T05P	Coastal Barrier Resource System Maps	1:24,000
M_6	TGLO	TGLO	Brazos River Complex T05/T05P /Sargent Beach Unit T06P	Coastal Barrier Resource System Maps	1:24,000
M_7	TGLO	TGLO	Sargent Beach Unit T06/T06P	Coastal Barrier Resource System Maps	1:24,000
M_8	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_9	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_10	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_11	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_12	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_13	TGLO	TGLO	Matagorda Peninsula Unit T07/T07P	Coastal Barrier Resource System Maps	1:24,000
M_14	TGLO	TGLO	Matagorda Peninsula Unit T07/TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_15	TGLO	TGLO	Matagorda Island Unit TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_16	TGLO	TGLO	Matagorda Island Unit TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_17	TGLO	TGLO	Matagorda Island Unit TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_18	TGLO	TGLO	Matagorda Island Unit TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_19	TGLO	TGLO	Matagorda Island Unit TX-06P	Coastal Barrier Resource System Maps	1:24,000
M_20	TGLO	TGLO	Matagorda Island Unit TX-06P/San Jose Island Complex T08	Coastal Barrier Resource System Maps	1:24,000
M_21	TGLO	TGLO	Matagorda Island Unit TX-06P/San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_22	TGLO	TGLO	San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_23	TGLO	TGLO	San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_24	TGLO	TGLO	San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_25	TGLO	TGLO	San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_26	TGLO	TGLO	San Jose Island Complex T08/T08P	Coastal Barrier Resource System Maps	1:24,000
M_27	TGLO	TGLO	Shamrock Island Unit TX-17/TX-17P	Coastal Barrier Resource System Maps	1:24,000
M_28	TGLO	TGLO	Mustang Island Unit TX-15P	Coastal Barrier Resource System Maps	1:24,000
M_29	TGLO	TGLO	Coon Island Bay Unit TX-09	Coastal Barrier Resource System Maps	1:24,000
M_30	TGLO	TGLO	Shell Beach Unit TX-10	Coastal Barrier Resource System Maps	1:24,000

NonGIS Digital Maps

ID	Available From	Originator/ Publisher	Location	Map	Scale
M_31	TGLO	TGLO	Four Mile Hill Unit TX-16P/North Padre Island Unit T10/T10P	Coastal Barrier Resource System Maps	1:24,000
M_32	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_33	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_34	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_35	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_36	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_37	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_38	TGLO	TGLO	North Padre Island Unit T10P	Coastal Barrier Resource System Maps	1:24,000
M_39	TGLO	TGLO	Starvation Point Unit TX-19/Kleberg Point Unit TX-21	Coastal Barrier Resource System Maps	1:24,000
M_40	TGLO	TGLO	North Padre Island Unit T10P/South Padre Island Unit T11/T11P	Coastal Barrier Resource System Maps	1:24,000
M_41	TGLO	TGLO	South Padre Island Unit T11P	Coastal Barrier Resource System Maps	1:24,000
M_42	TGLO	TGLO	South Padre Island Unit T11P	Coastal Barrier Resource System Maps	1:24,000
M_43	TGLO	TGLO	South Padre Island Unit T11/T11P	Coastal Barrier Resource System Maps	1:24,000
M_44	TGLO	TGLO	South Padre Island Unit T11/T11P	Coastal Barrier Resource System Maps	1:24,000
M_45	TGLO	TGLO	South Padre Island Unit T11/T11P	Coastal Barrier Resource System Maps	1:24,000
M_46	TGLO	TGLO	South Padre Island Unit T11/T11P/Andy Bowie UnitTX-22P	Coastal Barrier Resource System Maps	1:24,000
M_47	TGLO	TGLO	Boca Chica Unit T12/T12P	Coastal Barrier Resource System Maps	1:24,000
M_48	TGLO	TGLO	State Coast	Interactive Map of Coastal Management Program Zone Boundaries and Coastal Counties	
M_49	TGLO	TGLO	Aransas County	Land Use Maps for Management Area Counties	
M_50	TGLO	TGLO	Cameron County	Land Use Maps for Management Area Counties	
M_51	TGLO	TGLO	Kenedy County	Land Use Maps for Management Area Counties	
M_52	TGLO	TGLO	Kleberg County	Land Use Maps for Management Area Counties	
M_53	TGLO	TGLO	Nueces County	Land Use Maps for Management Area Counties	
M_54	TGLO	TGLO	San Patricio County	Land Use Maps for Management Area Counties	

NonGIS Digital Maps

ID	Available From	Originator/ Publisher	Location	Map	Scale
M_55	TGLO	TGLO	Willacy County	Land Use Maps for Management Area Counties	
M_56	TGLO	TGLO	San Antonio-Nueces Coastal Basin	Impaired Coastal Segments in Texas River Basins	
M_57	TGLO	TGLO	Nueces River Basin	Impaired Coastal Segments in Texas River Basins	
M_58	TGLO	TGLO	Nueces-Rio Grande Coastal Basin	Impaired Coastal Segments in Texas River Basins	
M_59	TGLO (NRI)	ELLIS	State Coast and Gulf	Land and Lease Information about state-owned submerged lands	
M_60	TGLO (NRI)	TCCC	State Coast	Texas Coastal Management Program Atlas	
M_61	TGLO (NRI)	CCC	State Coast	Texas Coastal Zone Map	
M_62	TGLO (NRI)	CCC	State Coast	Texas Coastal Zone Map (more detailed)	
M_63	TGLO (NRI)	CCC	State Coast	Navigatable Channels on the Texas Gulf Coast	
M_64	TGLO (NRI)	CCC	State Coast	Texas Gulf Intracoastal Waterway	
M_65	TGLO (NRI)	CCC	State Coast	Texas Coastal Management Program - Map Index	
M_66	TGLO	TGLO	State Coast	Texas Oil Spill Planning and Response Atlas Response Map Index	
M_67	TWDB	TWDB	State by Basin	Reservoir Basin Plates - Map Series	
M_68	TWDB	TWDB	State by region or Entire State	Regional Water Planning Group - Map Series	
M_69	TWDB	TWDB	State by county	Colonias - Map Series	
M_70	TGLO	TGLO	State	Mean Annual Total Precipitation (inches) in Texas	
M_71	TGLO	TGLO	State	Major Surface Water Basins of Texas	
M_72	TGLO	TGLO	State	TNRCC Permit-by-Basin Approach to Wastewater Permitting	
M_73	TGLO	TGLO	State	SB 503 Priority Areas and Regional Offices	
M_74	TGLO	TGLO	State	NPDES Cities and Counties Located in the Coastal Watersheds	
M_75	TWDB	TWDB	State	Major Aquifers	1:250,000
M_76	TWDB	TWDB	State	Minor Aquifers	1:250,000

NonGIS Digital Maps

ID	Available From	Originator/ Publisher	Location	Map	Scale
M_77	TWDB	TWDB	State	Major Surface/Groundwater Features	1:250,000 (counties and cities 1:100,000)
M_78	TWDB	TWDB	State	Major Surface Water Features	Basins@1:500,000 Rivers@1:2,000,000 Reservoirs@1:250,000
M_79	TWDB	TWDB	State	Major Texas Rivers	1:250,000
M_80	TWDB	TWDB	State	Major River Basins in Texas	1:500,000
M_81	TWDB	TWDB	State	Major River Basins in Texas over DEM	1:500,000
M_82	TWDB	TWDB	State	Wells Measured by TWDB and Cooperators	
M_83	TWDB	TWDB	State	Wells Sampled by TWDB for Water Quality Analysis	
M_84	TWDB	TWDB	State	Groundwater Management Areas	
M_85	TWDB	TWDB	State	Groundwater Management Areas with Major Aquifers	Aquifers@1:250,00 GMA@1:100,000
M_86	TWDB	TWDB	State	Groundwater Management Areas with Minor Aquifers	Aquifers@1:250,00 GMA@1:100,000
M_87	TWDB	TWDB	State	Groundwater Conservation Districts	
M_88	TWDB	TWDB	State	Groundwater Conservation Districts with Groundwater Management Areas	
M_89	TWDB	TWDB	State	Groundwater Conservation Districts, Groundwater Management Areas, and Priority Groundwater Management Areas	
M_90	TWDB	TWDB	State	Groundwater Conservation Districts and Major Aquifers and Priority Groundwater Management Areas	
M_91	TWDB	TWDB	State	Regional Water Planning Groups	
M_92	TWDB	TWDB	State	OPFCA Inspection and Field Support Services Offices	
M_93	TWDB	TWDB	State	Selected River Authorities and Special Law Districts	
M_94	TWDB	TWDB	State	River Authorities and Special Law Distyricts	

Maps and Data

ID	Available From	Originator/ Publisher	Location	Publication
P_1	GBIS	GBIS	Galveston Bay	Galveston Bay Bibliography
P_2	BEG		Gulf Shoreline	Changes in Gulf Shoreline Position: Mustang and North Padre Islands, Texas
P_3	TGLO	TGLO	Mission/Aransas	Mission/Aransas Watershed Wetland Conservation Plan
P_4	TGLO	TGLO	Mustang Island	21 Years of Shoreline Changes on Mustang Island Gulf Beach
P_5	TGLO	TGLO	Texas Coast	A bibliography of Texas Coastal Wetlands
P_6	TGLO (NRI)	GERG	Texas Coast	Aliphatics (Current)
P_7	TGLO (NRI)	GERG	Texas Coast	Aromatics (Current)
P_8	TGLO (NRI)	TPWD	Texas Coast	Bag Seine Sample Locations
P_9	TGLO (NRI)	TPWD	Texas Coast	Beach Seine Sample Locations
P_10	TGLO	CCC	Texas Coast	Dryland Rowcrop Agricultural Exemption Figures and Tables
P_11	USEPA	USEPA	Texas Coast	EMAP Estuaries: A report on the condition of the estuaries of the US in 1990-1993
P_12	TGLO (NRI)	TPWD	Texas Coast	Gill Net Sample Locations
P_13	TGLO	TGLO	Texas Coast	Monitoring the Impact of Dredging Activities on Coastal Wetland Resources
P_14	TGLO (NRI)	GERG	Texas Coast	Pesticides (Historical)
P_15	TGLO (NRI)	TPWD	Texas Coast	Recreational Fishing Survey Sample Locations (Ramp)
P_16	TGLO (NRI)	TPWD	Texas Coast	Recreational Fishing Survey Sample Locations (Roving Boat))
P_17	TGLO	TGLO	Texas Coast	Status and Trends of Wetland and Aquatic Habitats on Texas Barrier Islands, Matagorda Bay to San Antonio Bay
P_18	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_19	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_20	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_21	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_22	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_23	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Annual Report
P_24	TGLO	TGLO	Texas Coast	Texas Coastal Management Program Final Environmental Impact Statement
P_25	USFWS	USFWS	Texas Coast	Texas Coastal Wetlands: Status and Trends, mid-1950s to early 1990s
P_26	TGLO	TGLO	Texas Coast	Texas Coastwide Erosion Response Plan: A report to the 75th Texas Legislature
P_27	USEPA	USEPA	Texas Coast	The Ecological Condition of Estuaries in the Gulf of Mexico
P_28	TGLO (NRI)	TPWD	Texas Coast	Trawl Sample Locations
P_29	TGLO (NRI)	GERG	Texas Coast (except Sabine Lake)	Aromatics (Historical)
P_30	TGLO (NRI)	GERG	Texas Coast (except Sabine Lake)	Pesticides (Current)
P_31			Texas Coast (Upper)	Birds of the Upper Texas Coast

Maps and Data

ID	Available From	Originator/ Publisher	Location	Publication
P_32	TGLO (NRI)	ELLIS	Texas Coast and Gulf	Land and Lease Information about state-owned submerged lands
P_33	BEG		Texas Shoreline	Texas Shoreline Change Project. Coastal Mapping of West and East Bays in the Galveston Bay System using airborne LIDAR
P_34	BEG		Texas Shoreline	Texas Shoreline Change Project. Gulf of Mexico Shoreline Change from the Brazos River to Pass Cavallo
P_35	BEG		West Bay Shoreline	Changes in Bay Shoreline Position, West Bay System, Texas
P_36	TGLO (NRI)	TNRCC	State estuaries and tidal tributaries	Water and Sediment Quality Sample Locations
P_37	CKWRI	CKWRI	State	Caesar Kleberg Wildlife Research Institute
P_38	USEPA	USEPA	State	Environmental Monitoring and Assessment Program (EMAP)
P_39	UTCRWR	UTCRWR	State	UT Center for Research in Water Resources
P_40	TWRI	TWRI	State	Various technical reports from 2003 back to 1964
P_41			National	Biodiversity and Biological Collections Web Server
P_42	USGS	USGS	National	Biological Resources Division - USGS
P_43	USEPA	USEPA	National	Environmental Monitoring and Assessment Program (EMAP) Bibliographic Database
P_44	USEPA	USEPA	National	EPA Office of Wetlands, Oceans, and Watersheds
P_45	CMI	CMI	National	Fish and Wildlife Information Exchange
P_46	USGS	NWRC	National	National Wetlands Research Center
P_47	USGS	NWRC	National	National Wetlands Research Center
P_48	PWRC	PWRC	National	Patuxent Wildlife Research Center
P_49			National	Plants National Database
P_50	NPSC	NPSC	National	Wetland Restoration Bibliography
P_51	USACE	USACE	National	Wetlands Materials Index

Databases

ID	Database	Query info down to...				Who
		park	county	state	other	
D_1	Air Quality	no	no	no	sampling station	TCEQ
D_2	Amphibian Counts Database	?	?	?	?	USGS
D_3	ARMI	no	no	no	no	USGS
D_4	BEST_Biological and Ecotoxicological Characteristics of Terrestrial Vertebrate Species Residing in Estuaries	no	no	no	Gulf Coast	USGS
D_5	BEST_CEE-TV	no	no	yes	HUC, City, Species	USGS
D_6	BEST_Species Decline	no	no	no	Gulf Coast	USGS
D_7	Breeding Bird Census	?	?	?	?	USGS
D_8	Breeding Bird Survey	n	n	y	route	USGS
D_9	Butterflies of North America	no	yes	yes		USGS
D_10	Chinese Privet	no	yes	yes		NRCS/USDA
D_11	Christmas Bird Count	yes	no	yes	count	Audubon
D_12	Christmas Bird Count	no	no	no	count	USGS
D_13	eBird	yes	yes	yes	lat/long coordinates	
D_14	Envirofacts_Air Realeases (AIRS/AFS)		yes	yes	EPA region	EPA
D_15	Envirofacts_Environmental Radiation Ambient Monitoring System (ERAMS)		yes	yes	EPA region	EPA
D_16	Envirofacts_Multisystem Query		yes	yes	EPA region	EPA
D_17	Envirofacts_National Contaminant Occurrence Database (NCOD)		yes	yes	EPA region	EPA
D_18	Envirofacts_Toxic Release Inventory (TRI)		yes	yes	EPA region	EPA
D_19	Envirofacts_UV index		yes	yes	EPA region	EPA
D_20	Envirofacts_Water Discharge Permits (PCS)		yes	yes	EPA region	EPA
D_21	Inventory and Monitoring on National Parks	yes				NPS
D_22	MAPS	no	no	yes	region, station	USGS
D_23	MidWinter Bald Eagle Count	no	no	yes	route	
D_24	Mid-Winter Waterfowl Survey	no	no	yes	flyway, species, year	USFWS
D_25	Migratory Bird Data Center					USFWS/USGS
D_26	NAAMP	no	no	no	route	USGS
D_27	NARCAM	no	yes	no		USGS
D_28	National Atlas of the US					
D_29	NatureServe Explorer	no	no	yes	plant/animal, status	NatureServe
D_30	NBII			yes	lat/long coordinates	USGS
D_31	NBII Bird Conservation node					USGS
D_32	Nonindigenous Aquatic Species (NAS)	no	no	yes	HUCs (2 and 6)	USGS

Databases

ID	Database	Query info down to...				Who
		park	county	state	other	
D_33	NWIS Web Site	no	yes	yes	HUC, Sampling Site	USGS
D_34	NWQA Data Warehouse	no	no	no	study unit basin	USGS
D_35	PLANTS Database	no	no	yes		NRCS/USDA
D_36	Project Feeder Watch	no	no	yes		Cornell Lab of Ornithology
D_37	Toxic Release Inventory Program (TRI)					TNRCC
D_38	Water Quality	yes	no	no		NPS
D_39	Water Quality	no	no	no	sampling station	TCEQ
D_40	Waterbird Monitoring Patnership	no	no	no	site_ID	USGS
D_41	Waterfowl Breeding Population and Habitat Survey	no	no	?	species, year, strata	USFWS

NatureBib Maps

NBIB_ID	Author	Year	Title
504543	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing structure of the continental terrace in the Port Isabel 1 degrees by 2 degrees quadrangle, Texas Miscellaneous Investigations Series U S Geological Survey
504545	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing trace-metal content and texture of surficial bottom sediments in the Port Isabel 1 degrees by 2 degrees Quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
504544	Berryhill, H. L. J, and Trippet, A. R.,	1981	Map showing trace-metal content and texture of surficial bottom sediments in the Corpus Christi 1 degrees by 2 degrees quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
504541	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing nature of shallow subsurface sediments and biogeology in the Port Isabel 1 degrees by 2 degrees quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
533651	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing post-Wisconsin sedimentation patterns and faulting in the Port Isabel 1 degrees by 2 degrees quadrangle, Texas, U S Geol Surv, Misc Invest Ser (I 1254 D)
533652	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing post-Wisconsin sedimentation patterns and faulting in the Port Isabel 1 degrees by 2 degrees quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
533653	Berryhill, H. L. J, and Trippet, A. R.,	1981	Map showing post-Wisconsin sedimentation patterns and faulting in the Corpus Christi 1 degrees by 2 degrees quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
533655	Berryhill, H. L. J, and Trippet, A. R.,	1980	Map showing water circulation and rates of sedimentation in the Port Isabel 1 degrees by 2 degrees quadrangle, Texas, Miscellaneous Investigations Series U S Geological Survey
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Abbreviations	Description	Web Site
BEG	Bureau of Economic Geology (University of Texas, Austin)	http://www.beg.utexas.edu/
CCC	Texas Coastal Coordination Council	
CIR	Color Infra-Red	
CKWRI	Caesar Kleberg Wildlife Research Institute (Texas A&M)	http://www.ckwri.tamuk.edu/
CMU	Conservation Management Unit (Virginia Tech)	http://fwie.fw.vt.edu/WWW/nframes/info.htm
DEM	Digital Elevation Model	
DLG	Digital Line Graph	
DOQQ	Digital Ortho Quarter Quadrangle	
DRG	Digital Raster Graphics	
ELLIS	Energy Land and Lease Inventory System	
EMAP	Environmental Monitoring and Assessment Program	
FEMA	Federal Emergency and Management Agency	http://www.gismaps.fema.gov/rs.shtm
GBIS	Galveston Bay Information System	
GERG	Texas A&M University Geochemical and Environmental Research Group	
LAA	Landscape Analysis and Assessment	
LOSCO	Louisiana Oil Spill Coordinator's Office	
NED	National Elevation Dataset	
NGS	National Geodetic Survey	
NHD	National Hydrography Dataset	
NOAA	National Oceanic and Atmospheric Administration	
NOS	National Ocean Service	
NPS	National Park Service	
NPSC	Northern Prairie Science Center	http://www.npsc.nbs.gov/resource/literatr/wetresto/wetresto.htm
NRCS	Natural Resource Conservation Service	http://www.nrcs.usda.gov/technical/maps.html
NRI	Natural Resource Inventory	
NWRC	National Wetlands Research Center	
PWRC	Patuxent Wildlife Research Center	http://www.pwrc.nbs.gov/
RRC	Railroad Commission of Texas	http://www.rrc.state.tx.us/other-information/automated/itssmap.html
SARA	San Antonio River Authority	
TCEQ	Texas Commission on Environmental Quality	http://www.tceq.state.tx.us/
TCMS	Texas Centric Mapping System	
TCNRI	Texas Coastal Natural Resource Inventory	http://www.nri.state.tx.us/nri/
TGLO	Texas General Land Office	http://www.glo.state.tx.us/gisdata/gisdata.html
TLC	Texas Legislative Council	
TNRCC	Texas Natural Resource Conservation Commission	http://www.lib.utexas.edu/taro/tslac/20076/tsl-20076.html

Abbreviations	Description	Web Site
TNRIS	Texas Natural Resource Information System	http://www.tnris.state.tx.us/
TPWD	Texas Parks and Wildlife Department	
TSMS	Texas State Mapping System (State Plane Coordinate System)	
TWC	Texas Water Commission	
TWDB	Texas Water Development Board	http://www.twdb.state.tx.us/home/index.asp
TWRI	Texas Water Resources Institute	http://twri.tamu.edu/reports.php
TxDOT	Texas Department of Transportation	
USACE	United States Army Core of Engineers	http://www.wes.army.mil/el/wetlands/list.html
USEPA	United States Environmental Protection Agency	http://www.epa.gov/mrlc/data.html
USFS	US Forest Service	http://www.srs.fs.usda.gov/4803/landscapes/index.html
USFW	United States Fish and Wildlife Service	
USGS	United States Geological Survey	http://mapping.usgs.gov/products.html#digital_data
USMMS	U.S. Minerals Management Service	
UTCRWR	UT Center for Research in Water Resources	http://www.ce.utexas.edu/prof/maidment/gishydro/home.html
WRD	Water Resources Division	
NationalAtlas	National Atlas	http://nationalatlas.gov/atlasftp.html